INDIAN RHINOCEROS Studbook
(Rhinoceros unicorinis)

Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
55	F	11 Aug 1971	18	17	BASEL	11 Aug 1971	UNK	Captive Born	SWITZRLND		TUTUMA	
					ANTWERP	5 Sep 1972	UNK		BELGIUM			
56	F	24 Aug 1971	18	7	BASEL	24 Aug 1971	UNK	Captive Born	SWITZRLND		TAMAYA	
						24 Aug 1971	UNK					
57	M	12 Sep 1971	24	25	ASSAM	12 Sep 1971	UNK	Captive Born	INDIA		KRISHNA	
					NAGOYA	2 Oct 1974	UNK		JAPAN			
58	M	25 Nov 1971	76	77	HYDERABAD	25 Nov 1971	UNK	Captive Born	INDIA			
						25 Nov 1971	UNK					
						11 Aug 1983	(died)			11 Aug 1983		
59	F	27 Jan 1971	WILD	WILD	KAZIRANGA	27 Jan 1971	UNK	Captive Born	INDIA		RUKMINI	
					DELHI	28 Jan 1972	UNK		INDIA			
						????	(died)			????		
60	M	4 Apr 1972	18	31	BERLIN W	4 Apr 1972	UNK	Captive Born	W.GERMANY		KUMAR	
					WHIPSNADE	25 Mar 1976	UNK		ENGLAND			
61	M	????	WILD	WILD	ASSAM P	????	UNK	Wild Born	INDIA		SONTO	
					ASSAM	28 Jun 1971	UNK		INDIA			
					MYSORE	????	UNK		INDIA			
62	M	????	WILD	WILD	ASSAM P	????	UNK	Wild Born	INDIA		JAGIT	
					VEERMATA	14 Apr 1952	UNK		INDIA			
						14 Sep 1980	(died)			14 Sep 1980		
63	M	- Jun 1962	WILD	WILD	NEPAL	- Jun 1962	UNK	Wild Born	NEPAL		TINY	
					OMAHA	9 Sep 1966	UNK		U.S.A.			
						24 Feb 1975	(died)			24 Feb 1975		
64	F	- Sep 1973	WILD	WILD	ASSAM P	3 Jan 1974	UNK	Wild Born	INDIA		TAJA/JAJA	
					ASSAM	3 Jan 1974	UNK		INDIA			
					NAGOYA	2 Oct 1974	UNK		JAPAN			
65	M	20 Dec 1973	22	21	TOKYOUENO	20 Dec 1973	UNK	Captive Born	JAPAN		SAITARO	
					AMSTERDAM	12 Dec 1978	UNK		NETHERLND			
						24 May 1989	(died)			24 May 1989		
66	F	- 1974	WILD	WILD	ASSAM P	- 1974	UNK	Wild Born	INDIA		MAYANG KUM	
					ASSAM	- 1974	UNK		INDIA			
					NY BRONX	30 Jan 1975	UNK		U.S.A.			
67	F	- 1974	WILD	WILD	ASSAM P	- 1974	UNK	Wild Born	INDIA			
					ASSAM	- 1974	UNK		INDIA			
					NY BRONX	30 Jan 1975	UNK		U.S.A.			
68	M	3 Jan 1974	18	7	BASEL	3 Jan 1974	UNK	Captive Born	SWITZRLND			
						3 Jan 1974	UNK					
						3 Jan 1974	(died)			3 Jan 1974		

Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
69	M	30 Jan 1974	19	29	NZP-WASH	30 Jan 1974	UNK	Captive Born	U.S.A.		PATRICK	WASH 3
					TORONTO	16 Jun 1989	UNK		CANADA			
70	M	23 May 1974	24	25	ASSAM	23 May 1974	UNK	Captive Born	INDIA		LACHIT	
						23 May 1974	UNK					
					KANPUR	4 Mar 1977	UNK		INDIA			
71	M	5 Dec 1974	18	34	STUTTGART	5 Dec 1974	UNK	Captive Born	W.GERMANY		KABOR	
					GELSNKRCH	23 Nov 1976	UNK		W.GERMANY			
					SAO PAULO	31 Oct 1977	UNK		BRAZIL			
72	M	- 1958	WILD	WILD	NEPAL	31 Jan 1958	UNK	Wild Born	NEPAL		XIANGKA	
					PEKING	- Jul 1959	UNK		CHINA			
						12 Nov 1978 (died)				12 Nov 1978		
73	M	- Mar 1970	WILD	WILD	INDIA	1 Mar 1970	UNK	Wild Born	INDIA		YASSAM	
					ANTWERP	23 Mar 1973	UNK		BELGIUM			
						16 Oct 1988 (died)				16 Oct 1988		
74	M	- 1931	WILD	WILD	INDIA	31 Jan 1931	UNK	Wild Born	INDIA		HARRY	
					ST LOUIS	19 Jan 1934	UNK		U.S.A.			
						31 Dec 1961 (died)				31 Dec 1961		
75	M	- 1945	WILD	WILD	ASSAM P	31 Jan 1945	UNK	Wild Born	INDIA		KUSHAL	
					MADRAS	9 Jun 1953	UNK		INDIA			
76	M	- 1963	WILD	WILD	ASSAM P	31 Jan 1963	UNK	Wild Born	INDIA		RAJKUMAR	
					HYDERABAD	- 1965	UNK		INDIA			
						19 Aug 1983 (died)				19 Aug 1983		
77	F	- 1964	WILD	WILD	ASSAM P	31 Jan 1964	UNK	Wild Born	INDIA		RADHA	
					HYDERABAD	- 1968	UNK		INDIA			
						19 Aug 1983 (died)				19 Aug 1983		
78	M	24 Mar 1975	26	29	SD-WAP	24 Mar 1975	UNK	Captive Born	U.S.A.			SDWAP 1
						24 Mar 1975	UNK					
						25 Mar 1975 (died)				25 Mar 1975		
79	F	19 Jul 1975	1	11	MYSORE	19 Jul 1975	UNK	Captive Born	INDIA		INDIRA	
					TORONTO	27 Apr 1979	UNK		CANADA			
80	F	10 Oct 1975	18	7	BASEL	10 Oct 1975	UNK	Captive Born	SWITZRLND		XAVIRA	
					PHILADELP	6 Nov 1979	UNK		U.S.A.			
81	M	- 1972	WILD	WILD	ASSAM P	31 Jan 1972	UNK	Wild Born	INDIA			
					BROWNSVIL	12 Sep 1973	UNK		U.S.A.			
						3 Dec 1973 (died)				3 Dec 1973		
82	F	????	WILD	WILD	ASSAM P	1 Jan 1900	UNK	Wild Born	INDIA		PADUMI	
					ASSAM	3 Oct 1958	UNK		INDIA			
						28 Oct 1964 (died)				28 Oct 1964		

Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
83	M	18 Feb 1976	18	31	BERLIN W	18 Feb 1976	UNK	Captive Born	W.GERMANY		HEINER	
					(NY BRONX)	23 Dec 1983	UNK		U.S.A.			
84	M	26 Mar 1976	18	56	BASEL	26 Mar 1976	UNK	Captive Born	SWITZRLND		YAMATARI	
					KOLN	2 Nov 1978	UNK		W.GERMANY			
						6 Sep 1987 (died)				6 Sep 1987		
85	M	18 Oct 1976	26	29	SD-WAP	18 Oct 1976	UNK	Captive Born	U.S.A.		MAHARAJA	SDWAP 2
						18 Oct 1976	UNK					
						20 Oct 1976 (died)				20 Oct 1976		
86	M	21 Sep 1977	41	34	STUTTGART	21 Sep 1977	UNK	Captive Born	W.GERMANY		DVITYIA	
					DVURKRALV	12 Aug 1980	UNK		CZECHOSLO			
87	M	26 Jan 1978	18	56	BASEL	26 Jan 1978	UNK	Captive Born	SWITZRLND		ASSAM	
					NY BRONX	~ 1982	UNK		U.S.A.			
					MILWALKEE	31 Oct 1991	UNK		U.S.A.			
88	M	16 Jul 1979	18	7	BASEL	16 Jul 1978	UNK	Captive Born	SWITZRLND		ANGKOR	
						16 Jul 1978	UNK					
						19 Nov 1979 (died)				19 Nov 1978		
89	F	13 Aug 1979	32	31	BERLIN W	13 Aug 1979	UNK	Captive Born	W.GERMANY		TERAI	
					OKLAHOMA	10 Jul 1981	UNK		U.S.A.			
					LOSANGELE	13 Nov 1990	UNK		U.S.A.			
90	M	~ 1952	WILD	WILD	ASSAM P	31 Jan 1952	UNK	Wild Born	INDIA		JAI SINGH	
					LUCKNOW	30 Mar 1959	UNK		INDIA			
						6 May 1979 (died)				6 May 1979		
91	M	~ 1975	WILD	WILD	ASSAM P	31 Jan 1975	UNK	Wild Born	INDIA			
					LUCKNOW	20 Oct 1979	UNK		INDIA			
						18 Jan 1980 (died)				18 Jan 1980		
92	F	~ 1975	WILD	WILD	ASSAM P	31 Jan 1975	UNK	Wild Born	INDIA			
					LUCKNOW	20 Oct 1979	UNK		INDIA			
						???? (died)				????		
93	F	13 Sep 1979	41	34	STUTTGART	13 Sep 1979	UNK	Captive Born	W.GERMANY		MUNA	
					DVURKRALV	22 Jul 1981	UNK		CZECHOSLO			
94	M	1 Aug 1969	WILD	WILD	ASSAM P	1 Aug 1969	UNK	Wild Born	INDIA		MEGHNAD	
					CALCUTTA	14 Mar 1974	UNK		INDIA			
95	F	1 May 1973	WILD	WILD	ASSAM P	1 May 1973	UNK	Wild Born	INDIA		KADAMBENI	
					CALCUTTA	14 Mar 1974	UNK		INDIA			
96	M	12 Nov 1978	76	77	HYDERABAD	12 Nov 1978	UNK	Captive Born	INDIA		LADDU	
						12 Nov 1978	UNK					

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Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
97	F	9 Jan 1979	94	23	CALCUTTA	9 Jan 1979	UNK	Captive Born	INDIA			
						9 Jan 1979	UNK					
					KOLN	10 Mar 1986	UNK		W.GERMANY			
98	F	~ Sep 1979	WILD	WILD	NEPAL	1 Sep 1979	UNK	Wild Born	NEPAL		BHUNTI	
					PEKING	10 Sep 1980	UNK		CHINA			
99	F	19 Mar 1978	26	29	SD-WAP	19 Mar 1978	UNK	Captive Born	U.S.A.		GAINDA	SDWAP 3
						19 Mar 1978	UNK					
100	M	11 Jan 1980	18	56	BASEL	11 Jan 1980	UNK	Captive Born	SWITZRLND		CHITAWAN	
						11 Jan 1980	UNK					
101	M	8 Aug 1980	26	29	SD-WAP	9 Aug 1980	UNK	Captive Born	U.S.A.		PANDU	SDWAP 4
					NZP-WASH	25 Jun 1985	UNK		U.S.A.			
102	M	3 Nov 1980	73	55	ANTWERP	3 Nov 1980	UNK	Captive Born	BELGIUM			
						3 Nov 1980	UNK					
						7 Nov 1980 (died)				7 Nov 1980		
103	M	????	WILD	WILD	NEPAL	1 Jan 1960	UNK	Wild Born	NEPAL			
					RANGOON	27 Aug 1980	UNK		BURMA			
104	F	????	WILD	WILD	NEPAL	1 Jan 1960	UNK	Wild Born	NEPAL			
					RANGOON	27 Aug 1980	UNK		BURMA			
105	F	~ 1938	WILD	WILD	NEPAL	31 Jan 1938	UNK	Wild Born	NEPAL		ROSY	
					LUCKNOW	2 Feb 1944	UNK		INDIA			
						2 Apr 1973 (died)				2 Apr 1973		
106	M	15 May 1981	75	77	HYDERABAD	15 May 1981	UNK	Captive Born	INDIA		RASHA	
					SD-WAP	29 Jun 1985	UNK		U.S.A.			
107	F	21 May 1981	60	51	WHIPSNADE	21 May 1981	UNK	Captive Born	ENGLAND			
						21 May 1981	UNK					
						21 May 1981 (died)				21 May 1981		
108	M	~ 1980	WILD	WILD	NEPAL	31 Jan 1980	UNK	Wild Born	NEPAL		KUMAI	
					PEKING	20 Oct 1981	UNK		CHINA			
						26 Nov 1981 (died)				26 Nov 1981		
109	M	30 Aug 1981	41	54	STUTTGART	30 Aug 1981	UNK	Captive Born	W.GERMANY		NADIR	
					ROTTERDAM	15 Apr 1985	UNK		NETHERLND			
					SINGAPORE	25 May 1990	UNK		SINGAPORR			
110	F	16 Jan 1982	18	56	BASEL	16 Jan 1982	UNK	Captive Born	SWITZRLND		ELLORA	
111	F	16 Feb 1982	35	46	LOSANGELE	16 Feb 1982	UNK	Captive Born	U.S.A.		NEETHA	LA 1
					SD-WAP	18 Jun 1985	UNK		U.S.A.			
						22 Jun 1985 (died)				22 Jun 1985		

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Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth Origin	Country	Death Date	Name	Breeder #
112	M	25 Jul 1982	26	99	SD-WAP	25 Jul 1982	UNK	Captive Born	U.S.A.		TEZPUR	SDWAP 5
					SEOUL	27 Oct 1983	UNK		KOREA S			
						????	(died)			????		
113	F	9 Aug 1982	73	55	ANTWERP	9 Aug 1982	UNK	Captive Born	BELGIUM		JOHANNA	
114	F	- 1979	WILD	WILD	NEPAL	- 1979	UNK	Wild Born	NEPAL			
					KATHMANDU	17 May 1980	UNK		NEPAL			
115	M	????	60	51	WHIPSNADE	9 Mar 1983	UNK	Captive Born	ENGLAND		BHEEKA	
					ANTWERP	2 Oct 1985	UNK		BELGIUM			
116	M	1 May 1983	26	29	SD-WAP	1 May 1983	UNK	Captive Born	U.S.A.		JORHAT	SDWAP 6
					SANDIEGOZ	23 Jun 1986	UNK		U.S.A.			
					LOWRY	23 Jun 1986	UNK		U.S.A.			
117	M	12 Jul 1983	41	34	STUTTGART	12 Jul 1983	UNK	Captive Born	W.GERMANY		KATGIN	
					YOKOHAMA	27 Aug 1985	UNK		JAPAN			
118	F	25 Feb 1984	10	80	PHILADELP	25 Feb 1984	UNK	Captive Born	U.S.A.			PHILA 1
						26 Feb 1984	(died)			26 Feb 1984		
119	M	29 Feb 1984	18	56	BASEL	29 Feb 1984	UNK	Captive Born	SWITZRLND		GANDAK	
						11 Mar 1985	(died)			11 Mar 1985		
120	F	9 Aug 1982	35	45	LOSANGELE	9 Aug 1982	UNK	Captive Born	U.S.A.			
						9 Aug 1982	(died)			9 Aug 1982		
121	M	16 Dec 1983	35	45	LOSANGELE	16 Dec 1983	UNK	Unk Birth TypeU.S.A.				
						16 Dec 1983	(died)			16 Dec 1983		
122	F	1 Oct 1982	70	128	KANPUR	1 Oct 1982	UNK	Captive Born	INDIA		RAGHKI/SAW	
					YOKOHAMA	4 Dec 1985	UNK		JAPAN			
123	M	29 Jan 1985	41	34	STUTTGART	29 Jan 1985	UNK	Captive Born	W.GERMANY		BRUNO	
					KOLN	9 Dec 1987	UNK		W.GERMANY			
124	M	25 Jun 1985	26	99	SD-WAP	25 Jun 1985	UNK	Captive Born	U.S.A.		GURKHA	SDWAP
					SINGAPORE	26 Oct 1989	UNK		SINGAPORE			
125	M	11 Aug 1985	35	46	LOSANGELE	11 Aug 1985	UNK	Captive Born	U.S.A.		CHANDRA	LA 4
					OKLAHOMA	14 Nov 1990	UNK		U.S.A.			
125	M	3 Nov 1985	50	80	PHILADELP	3 Nov 1985	UNK	Captive Born	U.S.A.		AKBAR	PHILA 2
					METROZOO	1 Jan 1989	UNK		U.S.A.			
127	F	23 Nov 1985	42	40	BERLIN TP	23 Nov 1985	UNK	Captive Born	E.GERMANY			
						23 Nov 1985	(died)			23 Nov 1985		
128	F	11 Aug 1973	WILD	WILD	ASSAM P	11 Aug 1973	UNK	Wild Born	INDIA		MAYUNG	
					ASSAM	- 1977	UNK		INDIA			
					KANPUR	4 Mar 1977	UNK		INDIA			

Stud #	Sex	Birth Date	Sire	DAM	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
129	M	6 Dec 1984	70	128	KANPUR	6 Dec 1984	UNK	Captive Born	INDIA		LOHIT	
130	F	18 Jan 1985	26	99	SD-WAP	18 Jan 1985	UNK	Captive Born	U.S.A.		JUNIA	SDWAP 8
131	F	9 Apr 1986	83	66	NY BRONX	9 Apr 1986	UNK	Captive Born	U.S.A.			
132	M	9 Aug 1986	60	51	WHIPSNADE	9 Aug 1986	UNK	Captive Born	ENGLAND		YODHA	
					CHESTER	2 Dec 1987	UNK		ENGLAND			
133	F	10 Oct 1986	35	45	LOSANGELE	10 Oct 1986	UNK	Captive Born	U.S.A.			
						10 Oct 1986 (died)				10 Oct 1986		
134	M	24 Oct 1986	73	55	ANTWERP	24 Oct 1986	UNK	Captive Born	BELGIUM		NICO	
					ROTTERDAM	9 Oct 1990	UNK		NETHERLND			
135	M	24 Dec 1986	41	34	STUTTGART	24 Dec 1986	UNK	Captive Born	W.GERMANY		NOEL	
					NURNBERG	- Dec 1989	UNK		W.GERMANY			
136	M	- Apr 1986	WILD	WILD	NEPAL	- Apr 1986	UNK	Wild Born	NEPAL		CHHENDRA	
					SAN FRAN	26 May 1987	UNK		U.S.A.			
137	F	- Oct 1986	WILD	WILD	NEPAL	- Oct 1986	UNK	Wild Born	NEPAL		SHANTI	
					SAN FRAN	26 May 1987	UNK		U.S.A.			
138	F	- Mar 1986	WILD	WILD	NEPAL	- Mar 1986	UNK	Wild Born	NEPAL		MECHI	
					NZP-WASH	27 May 1987	UNK		U.S.A.			
139	F	- Nov 1986	WILD	WILD	NEPAL	- Nov 1986	UNK	Wild Born	NEPAL		KALI	
					NZP-WASH	27 May 1987	UNK		U.S.A.			
140	M	17 Jun 1987	70	128	KANPUR	17 Jun 1987	UNK	Captive Born	INDIA		MOHIT	
141	M	4 Nov 1987	86	93	DVURKRALV	4 Nov 1987	UNK	Captive Born	CZECHOSLO		NIK	
					LIBEREC	9 Nov 1989	UNK		CZECHOSLO			
142	M	7 Jan 1987	26	29	SD-WAP	7 Jan 1987	UNK	Captive Born	U.S.A.			
						7 Jan 1987 (died)				7 Jan 1987		
143	F	26 May 1987	26	99	SD-WAP	26 May 1987	UNK	Captive Born	U.S.A.		GOALPARA	SDWAP 9
144	F	- Dec 1987	WILD	WILD	NEPAL	- Dec 1987	UNK	Wild Born	NEPAL		KARAJANI	
					BERLIN W	15 May 1988	UNK		W.GERMANY			
145	M	8 May 1988	60	51	WHIPSNADE	8 May 1988	UNK	Captive Born	ENGLAND		ROPEN	
					DVURKRALV	16 Nov 1990	UNK		CZECHOSLO			
146	M	22 May 1988	26	29	SD-WAP	22 May 1988	UNK	Captive Born	U.S.A.		JOYA	SDWAP 10
					SANDIEGOZ	22 May 1988	UNK		U.S.A.			
147	M	14 Aug 1988	10	30	PHILADELP	14 Aug 1988	UNK	Captive Born	U.S.A.		JIMMY	PHILA 3
					CINCINNAT	24 Oct 1989	UNK		U.S.A.			

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Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth Origin	Country	Death Date	Name	Breeder #
148	F	4 Oct 1988	100	56	BASEL	4 Oct 1988	UNK	Captive Born	SWITZRLND		NASI	
					MUNICH	11 Jul 1990	UNK		W.GERMANY			
149	F	11 Dec 1988	100	110	BASEL	11 Dec 1988	UNK	Captive Born	SWITZRLND			
						11 Dec 1990 (died)				11 Dec 1990		
150	M	4 Jun 1984	94	95	CALCUTTA	4 Jun 1984	UNK	Captive Born	INDIA		DEBRAJ	
151	M	????	WILD	WILD	ASSAM P	- 1983	UNK	Wild Born	INDIA		DABBU	
					DELHI	3 Feb 1983	UNK		INDIA			
152	M	27 Nov 1988	41	34	STUTTGART	27 Nov 1988	UNK	Captive Born	W.GERMANY		NIKOLAUS	
					MUNICH	12 Jun 1990	UNK		W.GERMANY			
153	F	~ 1974	WILD	WILD	ASSAM P	~ 1976	UNK	Wild Born	INDIA		MURULI	
					NANDANKAN	8 Apr 1976	UNK		INDIA			
154	M	~ 1976	WILD	WILD	ASSAM P	- 1976	UNK	Wild Born	INDIA		NANDAN	
					NANDANKAN	2 Dec 1979	UNK		INDIA			
155	F	????	WILD	WILD	ASSAM P	????	UNK	Wild Born	INDIA		KANCHI	
					PATNA	28 May 1979	UNK		INDIA			
156	M	????	WILD	WILD	ASSAM P	????	UNK	Wild Born	INDIA		KANCHA	
					PATNA	28 May 1979	UNK		INDIA			
157	M	????	WILD	WILD	INDIA	????	UNK	Wild Born	INDIA		RAJU	
					PATNA	28 Mar 1982	UNK		INDIA			
158	F	25 Oct 1986	157	155	PATNA	25 Oct 1986	UNK	Captive Born	INDIA			
						25 Oct 1986 (died)				25 Oct 1986		
159	F	8 Jul 1988	157	155	PATNA	8 Jul 1988	UNK	Captive Born	INDIA		KARTALI	
160	M	23 Jun 1989	70	128	KANPUR	23 Jun 1989	UNK	Captive Born	INDIA		ROHIT	
161	F	9 May 1989	83	66	(NY BRONX)	9 May 1989	UNK	Captive Born	U.S.A.			OKLA 1
					OKLAHOMA	9 May 1989	UNK		U.S.A.			
162	M	2 Oct 1989	60	51	WHIPSNADE	2 Oct 1989	UNK	Captive Born	ENGLAND		BARDIA	
163	F	20 Apr 1989	106	99	SD-WAP	20 Apr 1989	UNK	Captive Born	U.S.A.			SDWAP 11
						20 Apr 1989	UNK					
						20 Apr 1989 (died)				20 Apr 1989		
164	M	~ Oct 1989	WILD	WILD	NEPAL	~ Oct 1989	UNK	Wild Born	NEPAL		KARNAK	
					SINGAPORE	7 May 1990	UNK		SINGAPORE			
165	F	~ Oct 1989	WILD	WILD	NEPAL	~ Oct 1989	UNK	Wild Born	NEPAL		KANCHAN	
					SINGAPORE	7 May 1990	UNK		SINGAPORE			

Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group
Data current thru: 31 Dec 1990 INTERNATIONAL

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20 Apr 1992

Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
166	M	1 Jan 1990	42	40	BERLIN TP	1 Jan 1990	UNK	Captive Born	E.GERMANY		BELJR	
167	F	14 Jan 1986	86	93	DVURKRALV	14 Jan 1986	UNK	Captive Born	CZECHOSLO		NELLY	
						27 Feb 1986 (died)				27 Feb 1986		
168	F	9 Jan 1978	24	25	ASSAM	9 Jan 1970	UNK	Captive Born	INDIA		LAKHIMI	
169	M	- 1976	WILD	WILD	ASSAM P	- 1976	UNK	Wild Born	INDIA		LAKHAN	
					ASSAM	27 Jan 1980	UNK		INDIA			
170	M	- Feb 1980	WILD	WILD	ASSAM P	- Feb 1980	UNK	Wild Born	INDIA		ZHDA	
					ASSAM	23 Aug 1980	UNK		INDIA			
171	F	- Jun 1980	WILD	WILD	ASSAM P	- Jun 1980	UNK	Wild Born	INDIA		GINI	
					ASSAM	25 Aug 1980	UNK		INDIA			
172	M	- 1972	WILD	WILD	ASSAM P	- 1972	UNK	Wild Born	INDIA		GANESH	
					ASSAM	15 Jul 1982	UNK		INDIA			
173	M	11 May 1987	UNK	UNK	ASSAM	11 May 1987	UNK	Captive Born	INDIA		BISHNU	
174	M	- Jan 1987	WILD	WILD	ASSAM P	- Jan 1987	UNK	Wild Born	INDIA		BATUL	
					ASSAM	25 Aug 1987	UNK		INDIA			
175	M	- Mar 1988	WILD	WILD	ASSAM P	- Mar 1988	UNK	Wild Born	INDIA		RAMU	
					ASSAM	2 Sep 1988	UNK		INDIA			
176	M	30 Mar 1989	UNK	168	ASSAM	30 Mar 1989	UNK	Captive Born	INDIA		MOHESH	
177	M	1 Jul 1988	WILD	WILD	ASSAM P	1 Jul 1988	UNK	Wild Born	INDIA		JADU	
					ASSAM	26 Jul 1989	UNK		INDIA			
178	M	- Jan 1989	WILD	WILD	ASSAM P	- 1989	UNK	Wild Born	INDIA		MADU	
					ASSAM	26 Jul 1989	UNK		INDIA			
179	M	- May 1990	WILD	WILD	ASSAM P	- May 1990	UNK	Wild Born	INDIA		PRADIP	
					ASSAM	20 Aug 1990	UNK		INDIA			
180	M	27 Jan 1990	26	29	SD-WAP	27 Jan 1990	UNK	Captive Born	U.S.A.		JAUNPUR	SDWAP 17
						27 Jan 1990	UNK					
181	M	31 May 1990	100	110	BASEL	31 May 1990	UNK	Captive Born	SWITZRLND		NANDI	
182	F	20 Jul 1990	106	130	SD-WAP	20 Jul 1990	UNK	Captive Born	U.S.A.		JHANSI	SDWAP 13
183	F	23 Oct 1990	100	56	BASEL	23 Oct 1990	UNK	Captive Born	SWITZRLND		NILGIRI	
184	M	28 Dec 1990	106	99	SD-WAP	28 Dec 1990	UNK	Captive Born	U.S.A.		GUJRAT	SDWAP 14
19009	M	24 Jul 1991	10	80	PHILADELP	24 Jul 1991	UNK	Captive Born	U.S.A.		DHALAGURI	PHILA 4
						24 Jul 1991	UNK					

Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
T9010	M	6 Jun 1989	WILD	WILD	FORTWORTH	10 May 1990	UNK	Wild Born	U.S.A.		ARUN	
						10 May 1990	UNK					
T9011	F	6 Jun 1989	WILD	WILD	FORTWORTH	10 May 1990	UNK	Wild Born	U.S.A.		ARATI	
						10 May 1990	UNK					
T9012	F	25 Dec 1991	69	79	TORONTO	25 Dec 1991	UNK	Captive Born	CANADA			TOR 1
						25 Dec 1991	UNK					
T9013	M	22 Dec 1991	106	143	SD-WAP	22 Dec 1991	UNK	Captive Born	U.S.A.		GANGTOK	SD-WAP 14
						22 Dec 1991	UNK					

TOTALS: 107.81.1 (189)

INDIAN RHINOCEROS Studbook
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Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
10	M	1 Jan 1955	WILD	WILD	ASSAM P	14 Sep 1955	UNK	Wild Born	INDIA		KANAKBALA	PHILA 1
					PHILADELP	14 Sep 1955	UNK		U.S.A.			
11	F	- 1948	WILD	WILD	ASSAM P	- 1948	UNK	Wild Born	INDIA		RANNI	
					MYSORE	- 1956	UNK		INDIA			
21	F	????	WILD	WILD	INDIA	????	UNK	Wild Born	INDIA		LAWIE/RANI	
					TOKYOUENO	- 1961	UNK		JAPAN			
					TOKYOTAMA	1 Jan 1989	UNK		JAPAN			
22	M	????	WILD	WILD	INDIA	????	UNK	Wild Born	INDIA		TAMAO/LUPS	
					TOKYOUENO	- 1961	UNK		JAPAN			
					TOKYOTAMA	1 Jan 1989	UNK		JAPAN			
26	M	31 Aug 1962	5	7	BASEL	31 Aug 1962	UNK	Captive Born	SWITZRLND		LASAI	
					SD-WAP	26 Apr 1972	UNK		U.S.A.			
29	F	10 Jul 1963	24	92	ASSAM	10 Jul 1963	UNK	Captive Born	INDIA		JAYPURI	
					SD-WAP	26 Apr 1972	UNK		U.S.A.			
31	F	12 Jun 1964	5	7	BASEL	12 Jun 1964	UNK	Captive Born	SWITZRLND		NIRIS	
					BERLIN W	6 May 1975	UNK		W.GERMANY			
32	M	11 Aug 1964	5	16	HAMBURG	11 Aug 1964	UNK	Captive Born	W.GERMANY		GAUHATI	
					BERLIN W	5 Aug 1965	UNK		W.GERMANY			
34	F	25 Aug 1965	5	17	BASEL	25 Aug 1965	UNK	Captive Born	SWITZRLND		NANDA	
					STUTTGART	24 Oct 1973	UNK		W.GERMANY			
35	M	- 1966	WILD	WILD	ASSAM P	8 Mar 1966	UNK	Wild Born	INDIA		HERMAN	LA 1
					LOSANGELE	8 Mar 1966	UNK		U.S.A.			
38	F	9 Apr 1967	19	16	HAMBURG	9 Apr 1967	UNK	Captive Born	W.GERMANY		SHITA	
						9 Apr 1967	UNK					
39	M	7 Jul 1967	18	7	BASEL	7 Jul 1967	UNK	Captive Born	SWITZRLND		PANDUR	
					HAMBURG	5 Sep 1968	UNK		W.GERMANY			
40	F	- May 1967	WILD	WILD	NEPAL	- May 1967	UNK	Wild Born	NEPAL		KUMARI	
					BERLIN TP	1 Aug 1967	UNK		E.GERMANY			
41	M	22 Dec 1967	18	17	BASEL	22 Dec 1967	UNK	Captive Born	SWITZRLND		PURI	
					STUTTGART	3 Jun 1969	UNK		W.GERMANY			
42	M	13 Feb 1968	1	11	MYSORE	13 Feb 1968	UNK	Captive Born	INDIA		MYSORE	
					BERLIN TP	24 Apr 1971	UNK		E.GERMANY			
45	F	5 Oct 1969	18	17	BASEL	5 Oct 1969	UNK	Captive Born	SWITZRLND		RANDA	BASEL 10
					LOSANGELE	22 Nov 1974	UNK		U.S.A.			

Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group
Data current thru: 31 Dec 1990 INTERNATIONAL

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Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
49	M	1 Jun 1969	WILD	WILD	NEPAL	23 Apr 1970	UNK	Wild Born	NEPAL		MOHAN	MIAMI 1
					METROZOO	23 Apr 1970	UNK		U.S.A.			
50	F	????	WILD	WILD	NEPAL	12 Jun 1970	UNK	Wild Born	NEPAL		SHANTI	MIAMI 2
					METROZOO	12 Jun 1970	UNK		U.S.A.			
					PHILADELP	10 Apr 1987	UNK		U.S.A.			
					NY BRONX	22 Nov 1988	UNK		U.S.A.			
					METROZOO	29 Mar 1990	UNK		U.S.A.			
51	F	27 Jan 1971	33	43	DELHI	27 Jan 1971	UNK	Captive Born	INDIA		ROOPA	
					WHIPSNADE	6 Feb 1973	UNK		ENGLAND			
53	M	16 Apr 1971	1	11	MYSORE	16 Apr 1971	UNK	Captive Born	INDIA		VINU	
					TORONTO	12 Jun 1976	UNK		CANADA			
					NY BRONX	30 May 1990	UNK		U.S.A.			
55	F	11 Aug 1971	16	17	BASEL	11 Aug 1971	UNK	Captive Born	SWITZRLND		TUTUMA	
					ANTWERP	5 Sep 1972	UNK		BELGIUM			
56	F	24 Aug 1971	16	7	BASEL	24 Aug 1971	UNK	Captive Born	SWITZRLND		TANAYA	
						24 Aug 1971	UNK					
57	M	12 Sep 1971	24	25	ASSAM	12 Sep 1971	UNK	Captive Born	INDIA		KRISHNA	
					NAGOYA	7 Oct 1974	UNK		JAPAN			
60	M	4 Apr 1972	18	31	BERLIN W	4 Apr 1972	UNK	Captive Born	W.GERMANY		KUMAR	
					WHIPSNADE	26 Mar 1976	UNK		ENGLAND			
61	M	????	WILD	WILD	ASSAM P	????	UNK	Wild Born	INDIA		SONTO	
					ASSAM	28 Jun 1971	UNK		INDIA			
					MYSORE	????	UNK		INDIA			
64	F	- Sep 1973	WILD	WILD	ASSAM P	3 Jan 1974	UNK	Wild Born	INDIA		TAJA/JAYA	
					ASSAM	3 Jan 1974	UNK		INDIA			
					NAGOYA	2 Dec 1974	UNK		JAPAN			
66	F	- 1974	WILD	WILD	ASSAM P	- 1974	UNK	Wild Born	INDIA		MAYANG KUM	
					ASSAM	- 1974	UNK		INDIA			
					NY BRONX	30 Jan 1975	UNK		U.S.A.			
67	F	- 1974	WILD	WILD	ASSAM P	- 1974	UNK	Wild Born	INDIA			
					ASSAM	- 1974	UNK		INDIA			
					NY BRONX	30 Jan 1975	UNK		U.S.A.			
69	M	30 Jan 1974	19	28	NZP-WASH	30 Jan 1974	UNK	Captive Born	U.S.A.		PATRICK	WASH 3
					TORONTO	16 Jun 1989	UNK		CANADA			
70	M	23 May 1974	24	25	ASSAM	23 May 1974	UNK	Captive Born	INDIA		LACHIT	
						23 May 1974	UNK					
					KANPUR	4 Mar 1977	UNK		INDIA			

INDIAN RHINOCEROS Studbook
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Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
71	M	5 Dec 1974	18	34	STUTTGART	5 Dec 1974	UNK	Captive Born	W.GERMANY		NABOR	
					GELSNKRKN	23 Nov 1976	UNK		W.GERMANY			
					SAO PAULO	31 Oct 1977	UNK		BRAZIL			
75	M	- 1945	WILD	WILD	ASSAM P	31 Jan 1945	UNK	Wild Born	INDIA		KUSHAL	
					MADRAS	9 Jan 1953	UNK		INDIA			
79	F	19 Jul 1975	1	11	MYSORE	19 Jul 1975	UNK	Captive Born	INDIA		INDIRA	
					TORONTO	27 Apr 1979	UNK		CANADA			
80	F	10 Oct 1975	18	7	BASEL	10 Oct 1975	UNK	Captive Born	SWITZRLND		XAVIRA	
					PHILADELP	6 Nov 1979	UNK		U.S.A.			
83	M	18 Feb 1976	18	31	BERLIN W	18 Feb 1976	UNK	Captive Born	W.GERMANY		HEINER	
					(NY BRONX)	23 Dec 1983	UNK		U.S.A.			
86	M	21 Sep 1977	41	34	STUTTGART	21 Sep 1977	UNK	Captive Born	W.GERMANY		SVETYTA	
					DVURKRALV	12 Aug 1980	UNK		CZECHOSLO			
87	M	26 Jan 1978	18	56	BASEL	26 Jan 1978	UNK	Captive Born	SWITZRLND		ASSAM	
					NY BRONX	- 1982	UNK		U.S.A.			
					MILWAUKEE	31 Oct 199[illegible]	UNK		U.S.A.			
89	F	13 Aug 1979	32	31	BERLIN W	13 Aug 1979	UNK	Captive Born	W.GERMANY		TERAI	
					OKLAHOMA	10 Jul 1981	UNK		U.S.A.			
					LOSANGELE	13 Nov 1990	UNK		U.S.A.			
93	F	13 Sep 1979	41	34	STUTTGART	13 Sep 1979	UNK	Captive Born	W.GERMANY		ANNA	
					DVURKRALV	22 Jul 1981	UNK		CZECHOSLO			
94	M	1 Aug 1969	WILD	WILD	ASSAM P	1 Aug 1969	UNK	Wild Born	INDIA		MEGHNAD	
					CALCUTTA	14 Mar 1974	UNK		INDIA			
95	F	1 May 1973	WILD	WILD	ASSAM P	1 May 1973	UNK	Wild Born	INDIA		KADAMBINI	
					CALCUTTA	14 Mar 1974	UNK		INDIA			
96	M	12 Nov 1978	76	77	HYDERABAD	12 Nov 1976	UNK	Captive Born	INDIA		LADDU	
						12 Nov 1978	UNK					
97	F	9 Jan 1979	94	23	CALCUTTA	9 Jan 1979	UNK	Captive Born	INDIA			
						9 Jan 1979	UNK					
					KOLN	13 Mar 1986	UNK		W.GERMANY			
98	F	- Sep 1979	WILD	WILD	NEPAL	1 Sep 1979	UNK	Wild Born	NEPAL		BHANTI	
					PEKING	13 Sep 1980	UNK		CHINA			
99	F	19 Mar 1978	26	29	SD-WAP	19 Mar 1978	UNK	Captive Born	U.S.A.		CHANDA	SDWAP 3
						19 Mar 1978	UNK					

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Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
100	M	11 Jan 1980	18	56	BASEL	11 Jan 1980	UNK	Captive Born	SWITZRLND		CHITAWAN	
						11 Jan 1980	UNK					
101	M	8 Aug 1980	26	29	SD WAP	8 Aug 1980	UNK	Captive Born	U.S.A.		PANDL	SDWAP 4
					NZP-WASH	25 Jun 1985	UNK		U.S.A.			
103	M	????	WILD	WILD	NEPAL	1 Jan 1900	UNK	Wild Born	NEPAL			
					RANGOON	27 Aug 1980	UNK		BURMA			
104	F	????	WILD	WILD	NEPAL	1 Jan 1900	UNK	Wild Born	NEPAL			
					RANGOON	27 Aug 1980	UNK		BURMA			
106	M	15 May 1981	76	77	HYDERABAD	15 May 1981	UNK	Captive Born	INDIA		RABHA	
					SD-WAP	29 Jun 1985	UNK		U.S.A.			
109	M	30 Aug 1981	41	34	STUTTGART	30 Aug 1981	UNK	Captive Born	W.GERMANY		NADIR	
					ROTTERDAM	13 Apr 1983	UNK		NETHERLND			
					SINGAPORE	25 May 1990	UNK		SINGAPORR			
110	F	16 Jan 1982	18	56	BASEL	16 Jan 1982	UNK	Captive Born	SWITZRLND		ELLORA	
113	F	9 Aug 1982	73	55	ANTWERP	9 Aug 1982	UNK	Captive Born	BELGIUM		JOHANNA	
114	F	- 1979	WILD	WILD	NEPAL	- 1979	UNK	Wild Born	NEPAL			
					KATHMANDU	17 May 1980	UNK		NEPAL			
115	M	????	63	51	WHIPSNADE	9 Mar 1983	UNK	Captive Born	ENGLAND		SHEEMA	
					ANTWERP	2 Oct 1985	UNK		BELGIUM			
116	M	1 May 1983	26	29	SD-WAP	1 May 1983	UNK	Captive Born	U.S.A.		JORHAT	SDWAP 6
					SANDIEGOZ	23 Jan 1986	UNK		U.S.A.			
					LOWRY	23 Jun 1986	UNK		U.S.A.			
117	M	12 Jul 1983	41	34	STUTTGART	12 Jul 1983	UNK	Captive Born	W.GERMANY		KATCIN	
					YOKOHAMA	27 Aug 1985	UNK		JAPAN			
122	F	1 Dec 1982	70	128	KANPUR	1 Dec 1982	UNK	Captive Born	INDIA		RASHMI/SAM	
					YOKOHAMA	4 Dec 1985	UNK		JAPAN			
123	M	29 Jan 1985	41	34	STUTTGART	29 Jan 1985	UNK	Captive Born	W.GERMANY		BRUNO	
					KOLN	9 Dec 1987	UNK		W.GERMANY			
124	M	25 Jun 1985	26	99	SD-WAP	25 Jun 1985	UNK	Captive Born	U.S.A.		GURKHA	SDWAP
					SINGAPORE	26 Oct 1989	UNK		SINGAPORR			
125	M	11 Aug 1985	35	46	LOSANGELE	11 Aug 1985	UNK	Captive Born	U.S.A.		CHANDRA	LA 4
					OKLAHOMA	14 Nov 1990	UNK		U.S.A.			
126	M	3 Nov 1985	10	80	PHILADELP	3 Nov 1985	UNK	Captive Born	U.S.A.		AKBAR	PHILA 2
					METROZOO	1 Jan 1989	UNK		U.S.A.			

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Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
128	F	11 Aug 1973	WILD	WILD	ASSAM P	11 Aug 1973	UNK	Wild Born	INDIA		MAYUHG	
					ASSAM	- 1977	UNK		INDIA			
					KANPUR	4 Mar 1977	UNK		INDIA			
129	M	6 Dec 1984	70	128	KANPUR	6 Dec 1984	UNK	Captive Born	INDIA		LOHIT	
130	F	18 Jan 1985	26	99	SD-WAP	18 Jan 1985	UNK	Captive Born	U.S.A.		JUNIA	SDWAP 8
131	F	9 Apr 1986	83	66	NY BRONX	9 Apr 1986	UNK	Captive Born	U.S.A.			
132	M	9 Aug 1986	60	51	WHIPSNADE	9 Aug 1986	UNK	Captive Born	ENGLAND		YOONA	
					CHESTER	2 Dec 1987	UNK		ENGLAND			
134	M	24 Oct 1986	73	55	ANTWERP	24 Oct 1986	UNK	Captive Born	BELGIUM		NICO	
					ROTTERDAM	9 Oct 1990	UNK		NETHERLND			
135	M	24 Dec 1986	41	34	STUTTGART	24 Dec 1986	UNK	Captive Born	W.GERMANY		NOEL	
					NURNBERG	- Dec 1989	UNK		W.GERMANY			
136	M	- Apr 1986	WILD	WILD	NEPAL	- Apr 1986	UNK	Wild Born	NEPAL		CHHENDRA	
					SAN FRAN	26 May 1987	UNK		U.S.A.			
137	F	- Oct 1986	WILD	WILD	NEPAL	- Oct 1986	UNK	Wild Born	NEPAL		SHANTI	
					SAN FRAN	26 May 1987	UNK		U.S.A.			
138	F	- Mar 1986	WILD	WILD	NEPAL	- Mar 1986	UNK	Wild Born	NEPAL		MECHI	
					NZP-WASH	27 May 1987	UNK		U.S.A.			
139	F	- Nov 1986	WILD	WILD	NEPAL	- Nov 1986	UNK	Wild Born	NEPAL		KALI	
					NZP-WASH	27 May 1987	UNK		U.S.A.			
140	M	17 Jun 1987	70	128	KANPUR	17 Jun 1987	UNK	Captive Born	INDIA		MOHIT	
141	M	4 Nov 1987	86	93	DVURKRALV	4 Nov 1987	UNK	Captive Born	CZECHOSLO		MIM	
					LIBEREC	9 Nov 1989	UNK		CZECHOSLO			
143	F	26 May 1987	26	99	SD-WAP	26 May 1987	UNK	Captive Born	U.S.A.		GOALAPARA	SDWAP 9
144	F	- Dec 1987	WILD	WILD	NEPAL	- Dec 1987	UNK	Wild Born	NEPAL		NARAJANI	
					BERLIN W	15 May 1988	UNK		W.GERMANY			
145	M	8 May 1988	60	51	WHIPSNADE	8 May 1988	UNK	Captive Born	ENGLAND		ROPEN	
					DVURKRALV	16 Nov 1990	UNK		CZECHOSLO			
146	M	22 May 1988	26	29	SD-WAP	22 May 1988	UNK	Captive Born	U.S.A.		JOTA	SDWAP 10
					SANDIEGOZ	22 May 1988	UNK		U.S.A.			
147	M	14 Aug 1988	10	80	PHILADELP	14 Aug 1988	UNK	Captive Born	U.S.A.		JIMMY	PHILA 3
					CINCINNAT	24 Oct 1989	UNK		U.S.A.			

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Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth Origin	Country	Death Date	Name	Breeder #
148	F	4 Oct 1988	103	56	BASEL	4 Oct 1988	UNK	Captive Born	SWITZHLND		HASI	
					MUNICH	11 Jul 1990	UNK		W.GERMANY			
150	M	4 Jun 1984	94	95	CALCUTTA	4 Jun 1984	UNK	Captive Born	INDIA		DEBRAJ	
151	M	????	WILD	WILD	ASSAM P	- 1983	UNK	Wild Born	INDIA		CABBU	
					DELHI	3 Feb 1983	UNK		INDIA			
152	M	27 Nov 1988	41	34	STUTTGART	27 Nov 1988	UNK	Captive Born	W.GERMANY		NIKOLAUS	
					MUNICH	12 Jun 1990	UNK		W.GERMANY			
153	F	- 1974	WILD	WILD	ASSAM P	- 1974	UNK	Wild Born	INDIA		NUMULI	
					NANDANKAN	8 Apr 1976	UNK		INDIA			
154	M	- 1976	WILD	WILD	ASSAM P	- 1976	UNK	Wild Born	INDIA		NANDAN	
					NANDANKAN	7 Dec 1979	UNK		INDIA			
155	F	????	WILD	WILD	ASSAM P	????	UNK	Wild Born	INDIA		KANCHI	
					PATNA	28 May 1979	UNK		INDIA			
156	M	????	WILD	WILD	ASSAM P	????	UNK	Wild Born	INDIA		KANCHA	
					PATNA	28 May 1979	UNK		INDIA			
157	M	????	WILD	WILD	INDIA	????	UNK	Wild Born	INDIA		RAJU	
					PATNA	28 Mar 1982	UNK		INDIA			
159	F	8 Jul 1988	157	155	PATNA	8 Jul 1988	UNK	Captive Born	INDIA		FARTALI	
160	M	23 Jun 1989	70	128	KANPUR	23 Jun 1989	UNK	Captive Born	INDIA		ROHIT	
161	F	9 May 1989	83	66	(NY BRONX)	9 May 1989	UNK	Captive Born	U.S.A.			OKLA 5
					OKLAHOMA	9 May 1989	UNK		U.S.A.			
162	M	2 Oct 1989	60	57	WHIPSNADE	2 Oct 1989	UNK	Captive Born	ENGLAND		BARDIA	
164	M	- Oct 1989	WILD	WILD	NEPAL	- Oct 1989	UNK	Wild Born	NEPAL		KARNAK	
					SINGAPORE	7 May 1990	UNK		SINGAPORR			
165	F	- Oct 1989	WILD	WILD	NEPAL	- Oct 1989	UNK	Wild Born	NEPAL		KANCHAN	
					SINGAPORE	7 May 1990	UNK		SINGAPORR			
166	M	1 Jan 1990	42	40	BERLIN TP	1 Jan 1990	UNK	Captive Born	E.GERMANY		RFLIR	
168	F	9 Jan 1978	24	25	ASSAM	9 Jan 1978	UNK	Captive Born	INDIA		LAKHMINI	
169	M	- 1976	WILD	WILD	ASSAM P	- 1976	UNK	Wild Born	INDIA		LAKHMAN	
					ASSAM	27 Jun 1980	UNK		INDIA			
170	M	- Feb 1980	WILD	WILD	ASSAM P	- Feb 1980	UNK	Wild Born	INDIA		JHON	
					ASSAM	23 Aug 1980	UNK		INDIA			

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Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth Origin	Country	Death-Date	Name	Breeder #
171	F	~ Jun 1980	WILD	WILD	ASSAM P	- Jun 1980	UNK	Wild Born	INDIA		GINI	
					ASSAM	23 Aug 1980	UNK		INDIA			
172	M	~ 1972	WILD	WILD	ASSAM P	~ 1972	UNK	Wild Born	INDIA		GANESH	
					ASSAM	15 Jul 1982	UNK		INDIA			
173	M	11 May 1987	UNK	UNK	ASSAM	11 May 1987	UNK	Captive Born	INDIA		BISHNU	
174	M	- Jan 1987	WILD	WILD	ASSAM P	~ Jan 1987	UNK	Wild Born	INDIA		BATUL	
					ASSAM	25 Aug 1987	UNK		INDIA			
175	M	- Mar 1988	WILD	WILD	ASSAM P	- Mar 1988	UNK	Wild Born	INDIA		RAMU	
					ASSAM	2 Sep 1988	UNK		INDIA			
176	M	30 Mar 1989	UNK	168	ASSAM	30 Mar 1989	UNK	Captive Born	INDIA		MOHESH	
177	M	1 Jul 1988	WILD	WILD	ASSAM P	1 Jul 1988	UNK	Wild Born	INDIA		JADU	
					ASSAM	26 Jul 1989	UNK		INDIA			
178	M	- Jan 1989	WILD	WILD	ASSAM P	- 1989	UNK	Wild Born	INDIA		MADU	
					ASSAM	26 Jul 1989	UNK		INDIA			
179	M	- May 1990	WILD	WILD	ASSAM P	- May 1990	UNK	Wild Born	INDIA		PRADIP	
					ASSAM	20 Aug 1990	UNK		INDIA			
180	M	27 Jan 1990	26	29	SD-WAP	27 Jan 1990	UNK	Captive Born	U.S.A.		JAUNPUR	SDWAP 12
						27 Jan 1990	UNK					
181	M	31 May 1990	100	110	BASEL	31 May 1990	UNK	Captive Born	SWITZRLND		NANDI	
182	F	20 Jul 1990	106	130	SD-WAP	20 Jul 1990	UNK	Captive Born	U.S.A.		JHANSI	SDWAP 13
183	F	23 Oct 1990	100	56	BASEL	23 Oct 1990	UNK	Captive Born	SWITZRLND		NILGIRI	
184	M	28 Dec 1990	106	99	SD-WAP	28 Dec 1990	UNK	Captive Born	U.S.A.		GUJRAT	SDWAP 16
19009	M	24 Jul 1991	10	80	PHILADELP	24 Jul 1991	UNK	Captive Born	U.S.A.		DHALAGURI	PHILA 4
						24 Jul 1991	UNK					
T9010	M	6 Jun 1989	WILD	WILD	FORTWORTH	10 May 1990	UNK	Wild Born	U.S.A.		ARUN	
						10 May 1990	UNK					
T9011	F	6 Jun 1989	WILD	WILD	FORTWORTH	10 May 1990	UNK	Wild Born	U.S.A.		ARATI	
						10 May 1990	UNK					
T9012	F	25 Dec 1991	69	79	TORONTO	25 Dec 1991	UNK	Captive Born	CANADA			TOR 1
						25 Dec 1991	UNK					
19013	M	22 Dec 1991	106	143	SD-WAP	22 Dec 1991	UNK	Captive Born	U.S.A.		GANGTOK	SDWAP 14
						22 Dec 1991	UNK					

TOTALS: 70.48.0 (118)

```
                                     Age Pyramid Report
                                 INDIAN RHINOCEROS Studbook
==============================================================================================
Taxon Name: RHINOCEROS UNICORINIS
==============================================================================================
Age                                          Males|Females
---                N =   63                 ---------------                N =   44
 47-                                          X |
 46-                                            |
 45-                                            |
 44-                                            | X
 43-                                            |
 42-                                            |
 41-                                            |
 40-                                            |
 39-                                            |
 38-                                            |
 37-                                          X |
 36-                                            |
 35-                                            |
 34-                                            |
 33-                                            |
 32-                                            |
 31-                                            |
 30-                                            |
 29-                                          X |
 28-                                            | X
 27-                                          X | X
 26-                                          X | X
 25-                                            | X
 24-                                        XXX | X
 23-                                            |
 22-                                         XX | X
 21-                                          X | X
 20-                                        XXX | XX
 19-                                            |
 18-                                          X | XXXXXX
 17-                                         XX |
 16-                                        XXX | XX
 15-                                            |
 14-                                         XX | XX
 13-                                          X | XX
 12-                                         XX | XXX
 11-                                          X | X
 10-                                         XX | X
  9-                                            | XX
  8-                                         XX |
  7-                                        XXX | X
  6-                                       XXXX | XX
  5-                                       XXXX | XX
  4-                                       XXXX | XX
  3-                                    XXXXXXX | XX
  2-                                     XXXXXX | XXX
  1-                                        XXX | XX
  0-                                         XX | X
- - - - - | - | - | - | - | - : - | - | - | - | - | - | - | - | - | - | - -   - | - - - -
         32   28   24   20   16   12   8    4        4    8   12   16   20   24   28   32
                                        Number of Animals

X >>> Specimens of known sex...
```

```
 ? >>> Specimens of unknown sex...
     7 Male Specimens of unknown age...
     4 Female Specimens of unknown age...
```

```
                                   Age Pyramid Report                             Report Date:
                                INDIAN RHINOCEROS Studbook                         20 Apr 1992
================================================================================================
Taxon Name: RHINOCEROS UNICORINIS                                                  Page    2
================================================================================================
Age  Studbook Numbers >>>  Male
---  ----------------
 47|      75
 46|
 45|
 44|
 43|
 42|
 41|
 40|
 39|
 38|
 37|      10
 36|
 35|
 34|
 33|
 32|
 31|
 30|
 29|      26
 28|
 27|      32
 26|      35
 25|
 24|      39      41      42
 23|
 22|      49      94
 21|      53
 20|      57      60     172
 19|
 18|      69
 17|      70      71
 16|      83     154     169
 15|
 14|      86      87
 13|      96
 12|     100     170
 11|     101
 10|     106     109
  9|
  8|     116     117
  7|     123     129     150
  6|     124     125     126     136
  5|     132     134     135     174
  4|     140     141     173     175
  3|     145     146     147     152     176     177     178
  2|     160     162     164     166     180   T9010
  1|     179     181     184
  0|   T9009   T9013
UNK|      22      61     103     115     151     156     157
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Total=   70

Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group                   SPARKS v1.11
```

```
                              Age Pyramid Report                   Report Date:
                         INDIAN RHINOCEROS Studbook                 20 Apr 1992
================================================================================
Taxon Name: RHINOCEROS UNICORNIS                                     Page     3
-----------  ---------  ==================================================
Age  Studbook Numbers >>>  Female
---  ----------------
 47|
 46|
 45|
 44|    11
 43|
 42|
 41|
 40|
 39|
 38|
 37|
 36|
 35|
 34|
 33|
 32|
 31|
 30|
 29|
 28|    29
 27|    31
 26|    34
 25|    38
 24|    40
 23|
 22|    45
 21|    51
 20|    55     56
 19|
 18|    64     66     67     95    128    153
 17|
 16|    79     80
 15|
 14|    99    168
 13|    97    114
 12|    89     93     98
 11|   171
 10|   110
  9|   113    122
  8|
  7|   130
  6|   131    138
  5|   137    139
  4|   143    144
  3|   148    159
  2|   161    165  T9011
  1|   182    183
  0|  T9012
UNK|    21     50    104    155
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Total=  48

Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group       SPARKS v1.11
```

Fecundity & Mortality Report

INDIAN RHINOCEROS Studbook

Taxon Name: **RHINOCEROS UNICORINIS**

	Fecundity [Mx]...				Mortality [Qx]...			
Age Class	Male	N	Female	N	Male	N	Female	N
0- 1	0.00	79.8	0.00	53.1	0.09	95.5	0.16	73.6
1- 2	0.00	78.9	0.00	54.4	0.05	80.1	0.04	54.0
2- 3	0.00	72.3	0.00	51.9	0.00	69.9	0.00	52.3
3- 4	0.00	66.9	0.00	48.5	0.00	66.9	0.04	48.3
4- 5	0.00	62.4	0.05	45.3	0.02	60.6	0.00	44.6
5- 6	0.00	56.8	0.03	43.0	0.00	56.8	0.00	42.6
6- 7	0.00	53.0	0.05	41.0	0.00	53.0	0.00	41.0
7- 8	0.01	49.9	0.07	40.3	0.00	49.3	0.00	40.3
8- 9	0.08	48.8	0.08	41.0	0.00	48.8	0.00	41.0
9-10	0.09	47.0	0.10	40.3	0.00	47.0	0.00	40.3
10-11	0.11	46.6	0.09	38.3	0.00	46.6	0.00	38.3
11-12	0.04	43.9	0.13	37.8	0.05	42.7	0.00	36.9
12-13	0.03	40.2	0.11	34.9	0.05	38.5	0.00	34.6
13-14	0.09	37.4	0.05	31.6	0.00	37.4	0.00	31.6
14-15	0.09	35.5	0.08	29.0	0.03	34.8	0.07	28.6
15-16	0.13	33.4	0.16	27.9	0.03	33.0	0.04	28.0
16-17	0.13	30.6	0.06	26.3	0.03	29.8	0.00	26.3
17-18	0.16	28.3	0.19	24.1	0.00	28.3	0.09	23.0
18-19	0.07	25.0	0.06	20.0	0.08	24.2	0.00	20.0
19-20	0.09	24.0	0.10	16.5	0.00	24.0	0.13	15.0
20-21	0.10	21.3	0.08	14.4	0.10	20.0	0.00	14.4
21-22	0.06	18.0	0.05	11.7	0.00	18.0	0.09	11.2
22-23	0.06	17.6	0.11	10.5	0.00	17.6	0.00	10.5
23-24	0.03	16.0	0.17	10.0	0.00	16.0	0.00	10.0
24-25	0.08	14.3	0.12	9.3	0.00	13.1	0.11	9.0
25-26	0.05	12.2	0.00	7.0	0.08	12.0	0.00	7.0
26-27	0.05	10.7	0.17	6.7	0.10	10.2	0.00	6.4
27-28	0.12	9.0	0.10	5.9	0.12	8.7	0.00	5.9
28-29	0.00	8.0	0.12	4.8	0.00	8.0	0.00	4.8
29-30	0.07	7.6	0.00	4.0	0.00	7.6	0.00	4.0
30-31	0.18	6.0	0.00	4.0	0.75	4.0	0.00	4.0
31-32	0.00	4.0	0.14	4.0	0.00	4.0	0.00	4.0
32-33	0.00	4.0	0.00	4.0	0.00	4.0	0.00	4.0
33-34	0.14	4.0	0.00	4.0	0.00	4.0	0.00	4.0
34-35	0.14	4.0	0.00	4.0	0.00	4.0	0.00	4.0
35-36	0.00	4.0	0.00	2.4	0.00	4.0	1.00	2.0
36-37	0.14	4.0	0.00	1.8	0.00	4.0	1.00	1.0
37-38	0.00	3.3	0.00	1.0	0.00	3.3	0.00	1.0
38-39	0.00	2.2	0.00	1.0	0.50	2.0	0.00	1.0
39-40	0.00	1.1	0.00	1.0	1.00	1.0	0.00	1.0
40-41	0.00	1.0	0.00	1.0	0.00	1.0	0.00	1.0
41-42	0.00	1.0	0.00	1.0	0.00	1.0	0.00	1.0
42-43	0.00	1.0	0.00	1.0	0.00	1.0	0.00	1.0
43-44	0.00	1.0	0.00	1.0	0.00	1.0	0.00	1.0
44-45	0.00	1.0	0.00	0.2	0.00	1.0	0.00	1.0
45-46	0.00	1.0	0.00	0.0	0.00	1.0	0.00	0.2
46-47	0.00	1.0	0.00	0.0	0.00	1.0	0.00	0.0
47-48	0.00	0.2	0.00	0.0	0.00	0.2	0.00	0.0
48-49	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
49-50	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0

```
                T  = 17.288    T  = 16.385     30 day mortality: 12%
                Ro =  1.234    Ro =  1.506        (18 out of 146)
                lambda=1.01    lambda=1.03
                r  =  0.012    r  =  0.025

           19 specimens of unknown age ignored...

           95 birth events to known age parents tabulated for Mx...plus...
             10 births to dams of unknown age...
              1 births to UNK or MULT dams...
              8 births to sires of unknown age...
              2 births to UNK or MULT sires...
           (129 parents (includes WILD) not found in data set ignored...)

           60 death events of known age tabulated for Qx...

    WARNING: Values with small sample sizes (N) warrant less confidence...
```

```
                        Fecundity & Mortality Report
Restricted to:          INDIAN RHINOCEROS Studbook
 Dates: During 01/01/1981 <= date
==========================================================================
Taxon Name: RHINOCEROS UNICORINIS
==========================================================================

                 Fecundity [Mx]...              Mortality [Qx]...
 Age Class     Male   N     Female   N        Male   N     Female   N
 ---------     ----  ---    ------  ---       ----  ---    ------  ---
   0- 1        0.00 37.9     0.00  18.9       0.07 40.9     0.25  27.8
   1- 2        0.00 38.3     0.00  21.2       0.05 38.2     0.05  20.2
   2- 3        0.00 33.3     0.00  21.6       0.00 33.3     0.00  21.6
   3- 4        0.00 28.8     0.00  19.7       0.00 28.8     0.05  20.3
   4- 5        0.00 23.8     0.06  17.3       0.00 23.8     0.00  17.3
   5- 6        0.00 22.8     0.03  16.4       0.00 22.8     0.00  16.4
   6- 7        0.00 20.4     0.10  15.3       0.00 20.4     0.00  15.3
   7- 8        0.03 19.4     0.03  18.9       0.00 19.4     0.00  18.9
   8- 9        0.12 18.0     0.08  20.0       0.00 18.0     0.00  20.0
   9-10        0.08 19.9     0.05  20.6       0.00 19.9     0.00  20.6
  10-11        0.16 20.7     0.10  20.3       0.00 20.7     0.00  20.3
  11-12        0.00 19.9     0.10  20.7       0.11 18.7     0.00  19.7
  12-13        0.03 17.6     0.14  18.9       0.00 17.6     0.00  18.9
  13-14        0.09 18.9     0.07  16.2       0.00 18.9     0.00  16.2
  14-15        0.06 17.9     0.03  15.4       0.00 17.9     0.00  15.4
  15-16        0.06 17.4     0.17  15.7       0.06 17.0     0.00  15.7
  16-17        0.14 15.4     0.10  15.8       0.00 15.4     0.00  15.8
  17-18        0.19 14.4     0.16  16.5       0.00 14.4     0.00  16.5
  18-19        0.04 13.6     0.07  14.1       0.08 13.0     0.00  14.1
  19-20        0.12 14.0     0.14  11.7       0.00 14.0     0.20  10.2
  20-21        0.14 11.5     0.00  10.4       0.09 11.0     0.00  10.4
  21-22        0.06  9.0     0.07   7.7       0.00  9.0     0.14   7.2
  22-23        0.11  9.7     0.08   6.5       0.00  9.7     0.00   6.5
  23-24        0.06  9.0     0.18   6.0       0.00  9.0     0.00   6.0
  24-25        0.13  8.0     0.10   5.3       0.00  7.1     0.20   5.0
  25-26        0.09  6.2     0.00   3.0       0.17  6.0     0.00   3.0
  26-27        0.10  5.7     0.20   2.7       0.19  5.2     0.00   2.7
  27-28        0.11  4.7     0.00   1.9       0.00  4.7     0.00   1.9
  28-29        0.00  4.0     0.00   0.8       0.00  4.0     0.00   0.8
  29-30        0.15  3.6     0.00   0.0       0.00  3.6     0.00   0.0
  30-31        0.25  2.1     0.00   0.1       1.00  1.0     0.00   0.1
  31-32        0.00  1.0     0.00   1.0       0.00  1.0     0.00   1.0
  32-33        0.00  1.0     0.00   1.1       0.00  1.0     0.00   1.1
  33-34        0.54  1.0     0.00   2.1       0.00  1.0     0.00   2.1
  34-35        0.00  1.0     0.00   3.0       0.00  1.0     0.00   3.0
  35-36        0.00  1.1     0.00   2.2       0.00  1.1     0.50   2.0
  36-37        0.26  2.1     0.00   1.8       0.00  2.1     1.00   1.0
  37-38        0.00  2.3     0.00   1.0       0.00  2.3     0.00   1.0
  38-39        0.00  2.0     0.00   1.0       0.00  2.0     0.00   1.0
  39-40        0.00  1.1     0.00   1.0       1.00  1.0     0.00   1.0
  40-41        0.00  1.0     0.00   1.0       0.00  1.0     0.00   1.0
  41-42        0.00  1.0     0.00   1.0       0.00  1.0     0.00   1.0
  42-43        0.00  1.0     0.00   1.0       0.00  1.0     0.00   1.0
  43-44        0.00  1.0     0.00   1.0       0.00  1.0     0.00   1.0
  44-45        0.00  1.0     0.00   0.2       0.00  1.0     0.00   0.2
  45-46        0.00  1.0     0.00   0.0       0.00  1.0     0.00   0.0
  46-47        0.00  1.0     0.00   0.0       0.00  1.0     0.00   0.0
  47-48        0.00  0.2     0.00   0.0       0.00  0.2     0.00   0.0
  48-49        0.00  0.0     0.00   0.0       0.00  0.0     0.00   0.0
  49-50        0.00  0.0     0.00   0.0       0.00  0.0     0.00   0.0
```

```
             T  = 17.121    T  : 15.000     30 day mortality: 15%
             Ro =  1.389    Ro =  1.215        (10 out of 66)
             lambda=1.02    lambda=1.01
             r  =  0.019    r  =  0.013

        51 birth events to known age parents tabulated for Mx...plus...
           2 births to dams of unknown age...
           1 births to UNK or MULT dams...
           2 births to sires of unknown age...
           2 births to UNK or MULT sires...

        30 death events of known age tabulated for Qx...

  WARNING: Values with small sample sizes (N) warrant less confidence...

 Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group               SPARKS v1.11
 Data current thru: 31 Dec 1990 INTERNATIONAL                                  21 Apr 1992
```

```
                              Fecundity & Mortality Report
Restricted to:                  INDIAN RHINOCEROS Studbook
 Dates: During 01/01/1982 <- date
------------------------------------------------------------------------------------------
Taxon Name: RHINOCEROS UNICORINIS
------------------------------------------------------------------------------------------

                    Fecundity [Mx]...                  Mortality [Qx]...
 Age Class       Male    N      Female    N          Male    N      Female    N
 ---------       ----   ---     ------   ---         ----   ---     ------   ---

   0- 1          0.00  36.2      0.00   18.5         0.08  39.2      0.24   25.4
   1- 2          0.00  35.2      0.00   18.7         0.03  34.9      0.06   17.7
   2- 3          0.00  32.3      0.00   18.4         0.00  32.3      0.00   18.4
   3- 4          0.00  27.0      0.00   17.9         0.00  27.0      0.05   18.6
   4- 5          0.00  23.1      0.06   17.3         0.00  23.1      0.00   17.3
   5- 6          0.00  19.2      0.04   15.0         0.00  19.2      0.00   15.0
   6- 7          0.00  19.0      0.12   13.6         0.00  19.0      0.00   13.6
   7- 8          0.03  16.9      0.04   14.4         0.00  16.9      0.00   14.4
   8- 9          0.12  17.7      0.09   18.6         0.00  17.7      0.00   18.6
   9-10          0.07  16.3      0.06   19.3         0.00  16.3      0.00   19.3
  10-11          0.17  19.5      0.09   18.6         0.00  19.5      0.00   18.6
  11-12          0.00  18.0      0.11   19.8         0.12  16.9      0.00   18.9
  12-13          0.03  16.5      0.15   17.8         0.00  16.5      0.00   17.8
  13-14          0.07  16.6      0.07   15.6         0.00  16.6      0.00   15.6
  14-15          0.06  17.3      0.04   14.0         0.00  17.3      0.00   14.0
  15-16          0.07  16.5      0.18   15.0         0.06  16.1      0.00   15.0
  16-17          0.15  14.8      0.07   14.9         0.00  14.8      0.00   14.9
  17-18          0.19  13.9      0.15   14.5         0.00  13.9      0.00   14.5
  18-19          0.00  11.9      0.08   13.6         0.09  11.3      0.00   13.6
  19-20          0.13  12.8      0.15   10.6         0.00  12.8      0.22    9.1
  20-21          0.14  11.5      0.00    9.5         0.09  11.0      0.00    9.5
  21-22          0.06   9.0      0.07    7.7         0.00   9.0      0.14    7.2
  22-23          0.13   8.6      0.08    6.5         0.00   8.6      0.00    6.5
  23-24          0.07   8.1      0.18    6.0         0.00   8.1      0.00    6.0
  24-25          0.15   7.3      0.10    5.3         0.00   6.4      0.20    5.0
  25-26          0.09   5.9      0.00    3.0         0.18   5.7      0.00    3.0
  26-27          0.12   4.7      0.20    2.7         0.24   4.2      0.00    2.7
  27-28          0.12   4.7      0.00    1.9         0.00   4.7      0.00    1.9
  28-29          0.00   4.0      0.00    0.8         0.00   4.0      0.00    0.8
  29-30          0.15   3.6      0.00    0.0         0.00   3.6      0.00    0.0
  30-31          0.25   2.1      0.00    0.0         1.00   1.0      0.00    0.0
  31-32          0.00   1.0      0.00    0.1         0.00   1.0      0.00    0.1
  32-33          0.00   1.0      0.00    1.0         0.00   1.0      0.00    1.0
  33-34          0.54   1.0      0.00    1.1         0.00   1.0      0.00    1.1
  34-35          0.00   1.0      0.00    2.1         0.00   1.0      0.00    2.1
  35-36          0.00   1.0      0.00    2.2         0.00   1.0      0.50    2.0
  36-37          0.50   1.1      0.00    1.8         0.00   1.1      1.00    1.0
  37-38          0.00   1.4      0.00    1.0         0.00   1.4      0.00    1.0
  38-39          0.00   2.0      0.00    1.0         0.00   2.0      0.00    1.0
  39-40          0.00   1.1      0.00    1.0         1.00   1.0      0.00    1.0
  40-41          0.00   1.0      0.00    1.0         0.00   1.0      0.00    1.0
  41-42          0.00   1.0      0.00    1.0         0.00   1.0      0.00    1.0
  42-43          0.00   1.0      0.00    1.0         0.00   1.0      0.00    1.0
  43-44          0.00   1.0      0.00    1.0         0.00   1.0      0.00    1.0
  44-45          0.00   1.0      0.00    0.2         0.00   1.0      0.00    0.2
  45-46          0.00   1.0      0.00    0.0         0.00   1.0      0.00    0.0
  46-47          0.00   1.0      0.00    0.0         0.00   1.0      0.00    0.0
  47-48          0.00   0.2      0.00    0.0         0.00   0.2      0.00    0.0
  48-49          0.00   0.0      0.00    0.0         0.00   0.0      0.00    0.0
  49-50          0.00   0.0      0.00    0.0         0.00   0.0      0.00    0.0
```

```
            T  = 17.218    T  = 14.673     30 day mortality: 14%
            Ro =  1.394    Ro =  1.255        (9 out of 63)
            lambda=1.02    lambda=1.02
            r  =  0.019    r  =  0.015

        48 birth events to known age parents tabulated for Mx...plus...
           2 births to dams of unknown age...
           1 births to UNK or MULT dams...
           2 births to sires of unknown age...
           2 births to UNK or MULT sires...

        28 death events of known age tabulated for Qx...

 WARNING: Values with small sample sizes (N) warrant less confidence...
```

FOUNDER ANALYSIS - *RHINOCEROS UNICORINIS* - WORLD - 20/04/1992

Founder representation in each living animal:
  Founders listed across top, descendants down side.
  Founder calculations omit UNKNOWNs.
  Studbook numbers beginning with **P** indicate wild or unknown founders that
    mated with studbook # without the P to produce CB offspring.

Founders:

```
           21        22        24        25        50        61        82
          103       104       151       155       156       157         1
           75         7         5        11        30        10        16
           18        15       P21        33        43        76       P30
           77        35        40        46        49        94        73
          172        95       128        64       153        66        67
          154       169       114        98       170       171       138
          136       137       139       174       144       175       177
          176     T9010     T9011       164       165       179
```

Founder contributions:

```
       0.2500    0.0000    5.1250    2.7500    0.0000    0.0000    2.3750
       0.0000    0.0000    0.0000    0.5000    0.0000    0.5000    2.0000
       0.0000   12.7500   12.2500    2.0000    0.3750    1.5000    1.2500
      14.0000    0.7500    0.2500    1.5000    1.5000    1.7500    0.3750
       1.7500    0.5000    0.5000    0.5000    0.0000    1.0000    1.0000
       0.0000    0.5000    2.0000    0.0000    0.0000    1.0000    0.0000
       0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
       0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
       0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
```

Fractional contributions:

```
       0.0034    0.0000    0.0707    0.0379    0.0000    0.0000    0.0328
       0.0000    0.0000    0.0000    0.0069    0.0000    0.0069    0.0276
       0.0000    0.1759    0.1690    0.0276    0.0052    0.0207    0.0172
       0.1931    0.0103    0.0034    0.0207    0.0207    0.0241    0.0052
       0.0241    0.0069    0.0069    0.0069    0.0000    0.0138    0.0138
       0.0000    0.0069    0.0276    0.0000    0.0000    0.0138    0.0000
       0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
       0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
       0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
```

Number of living descendants:

```
            1         0        20         8         0         0        12
            0         0         0         1         0         1         5
            0        49        38         5         2         3         3
           35         2         1         5         5         5         2
            5         1         1         1         0         2         2
            0         1         4         0         0         2         0
            0         0         0         0         0         0         0
            0         0         0         0         0         0         0
            0         0         0         0         0         0
```

GENE DROP ANALYSIS - *RHINOCEROS UNICORINIS* - WORLD - 20/04/1992

Studbook		Sire	Dam	Status (cap=alive)	Prop. genome living desc.	unique among all living
21	F	WILD	WILD	f		
22	M	WILD	WILD	F		1.0000
24	M	WILD	WILD	f		
25	F	WILD	WILD	f		
50	F	WILD	WILD	F		1.0000
61	M	WILD	WILD	F		1.0000
82	F	WILD	WILD	f		
103	M	WILD	WILD	F		1.0000
104	F	WILD	WILD	F		1.0000
151	M	WILD	WILD	F		1.0000
155	F	WILD	WILD	F		0.5000
156	M	WILD	WILD	F		1.0000
157	M	WILD	WILD	F		0.5000
1	M	WILD	WILD	f		
75	M	WILD	WILD	F		1.0000
7	F	WILD	WILD	f		
5	M	WILD	WILD	f		
11	F	WILD	WILD	F		0.1240
30	F	WILD	WILD	f		
10	M	WILD	WILD	F		0.1315
16	F	WILD	WILD	f		
18	M	WILD	WILD	f		
17	F	5	7	d		
19	M	WILD	WILD	f		
P21	M	WILD	WILD	f		
23	F	P21	21	d		
33	M	WILD	WILD	f		
43	F	WILD	WILD	f		
26	M	5	7	A	0.0000	0.0000
76	M	WILD	WILD	f		
P30	M	WILD	WILD	f		
28	F	P30	30	d		
29	F	24	82	A	0.0155	0.0155
77	F	WILD	WILD	f		
31	F	5	7	A	0.0085	0.0085
32	M	5	16	A	0.1370	0.1370
34	F	5	17	A	0.0000	0.0000
35	M	WILD	WILD	F		0.5000
38	F	18	16	A	0.2525	0.2525
40	F	WILD	WILD	F		0.5000
39	M	19	7	A	0.0205	0.0205
41	M	18	17	A	0.0000	0.0000
42	M	1	11	A	0.1330	0.0565
46	F	WILD	WILD	f		
49	M	WILD	WILD	F		1.0000
94	M	WILD	WILD	F		0.2490
45	F	18	17	A	0.0020	0.0020
73	M	WILD	WILD	f		
51	F	33	43	A	0.0575	0.0575
53	M	1	11	A	0.2525	0.1330
55	F	18	17	A	0.0015	0.0015
56	F	18	7	A	0.0005	0.0005
57	M	24	25	A	0.1815	0.1815
172	M	WILD	WILD	F		1.0000
60	M	19	31	A	0.0000	0.0000
95	F	WILD	WILD	F		0.5000
128	F	WILD	WILD	F		0.0535

Studbook	Sire	Dam	Status (cap=alive)	Prop. genome living desc.	unique among all living
64 F	WILD	WILD	F		1.0000
153 F	WILD	WILD	F		1.0000
69 M	13	28	A	0.5000	0.5000
66 F	WILD	WILD	F		0.2515
67 F	WILD	WILD	F		1.0000
70 M	24	25	A	0.0170	0.0170
71 M	18	34	A	0.0000	0.0000
79 F	1	11	A	0.1235	0.0580
80 F	18	7	A	0.0050	0.0050
154 M	WILD	WILD	F		1.0000
149 M	WILD	WILD	F		1.0000
83 M	18	31	A	0.0000	0.0000
86 M	41	34	A	0.0000	0.0000
168 F	24	25	A	0.0955	0.0955
87 M	18	56	A	0.0005	0.0005
99 F	26	29	A	0.0000	0.0000
96 M	76	77	A	0.5015	0.5015
114 F	WILD	WILD	F		1.0000
97 F	94	23	A	0.7510	0.5000
89 F	32	31	A	0.0000	0.0000
98 F	WILD	WILD	F		1.0000
93 F	41	34	A	0.0000	0.0000
100 M	18	56	A	0.0000	0.0000
170 M	WILD	WILD	F		1.0000
171 F	WILD	WILD	F		1.0000
101 M	26	29	A	0.0000	0.0000
106 M	76	77	A	0.0615	0.0615
109 M	41	34	A	0.0000	0.0000
110 F	18	56	A	0.0000	0.0000
113 F	73	55	A	0.2375	0.2375
122 F	70	128	A	0.0580	0.0000
116 M	26	29	A	0.0000	0.0000
117 M	41	34	A	0.0000	0.0000
150 M	94	95	A	0.7510	0.0000
129 M	70	128	A	0.0630	0.0000
130 F	26	99	A	0.0000	0.0000
123 M	41	34	A	0.0000	0.0000
124 M	26	99	A	0.0000	0.0000
125 M	35	46	A	1.0000	0.5000
126 M	10	80	A	0.1310	0.0000
138 F	WILD	WILD	F		1.0000
136 M	WILD	WILD	F		1.0000
131 F	43	66	A	0.2485	0.0000
132 M	60	51	A	0.0000	0.0000
137 F	WILD	WILD	F		1.0000
134 M	73	55	A	0.2375	0.2375
139 F	WILD	WILD	F		1.0000
135 M	41	34	A	0.0000	0.0000
174 M	WILD	WILD	F		1.0000
173 M	UNK	UNK	U		1.0000
143 F	26	99	A	0.0000	0.0000
140 M	70	128	A	0.0725	0.0000
141 M	86	93	A	0.0000	0.0000
144 F	WILD	WILD	F		1.0000
175 M	WILD	WILD	F		1.0000
145 M	60	51	A	0.0000	0.0000
146 M	26	29	A	0.0000	0.0000
177 M	WILD	WILD	F		1.0000
159 F	157	155	A	1.0000	0.0000
147 M	10	80	A	0.1200	0.0000
148 F	100	56	A	0.0000	0.0000

```
Studbook      Sire         Dam   Status    Prop. genome unique among
                                (dap=alive) living desc.   all living

    152 M       41          34   A            0.0000        0.0000
    178 M     WILD        WILD   F                          1.0000
   ?166 M      UNK         UNK   U
    176 M     ?166         168   A            0.5000        0.5000
    161 F       83          66   A            0.2485        0.0000
  T9010 M     WILD        WILD   F                          1.0000
  T9011 F     WILD        WILD   F                          1.0000
    160 M       70         128   A            0.0650        0.0000
    164 M     WILD        WILD   F                          1.0000
    165 F     WILD        WILD   F                          1.0000
    162 M       60          51   A            0.0000        0.0000
    166 M       42          40   A            0.5000        0.0000
    180 M       26          29   A            0.0000        0.0000
    179 M     WILD        WILD   F                          1.0000
    181 M      100         110   A            0.0000        0.0000
    182 F      106         130   A            0.0000        0.0000
    183 F      100          56   A            0.0000        0.0000
    184 M      106          99   A            0.0000        0.0000
  T9009 M       10          80   A            0.1175        0.0000
  T9013 M      106         143   A            0.0000        0.0000
  T9012 F       69          79   A            0.0000        0.0000
    115 M       60          51   A            0.0000        0.0000

-------------------------------------- -- ----------------------------------------

   64 Founders       73 Living descendants      140 In total pedigree
```

FOUNDER ALLELE REPRESENTATION

Founder	Retention	%Representation		Target		Difference	
		with unk	w/o	with unk	w/o	with unk	w/o
21 F	0.253	0.346	0.348	0.446	0.458	0.100	0.110
22 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
24 M	0.944	7.016	7.065	1.666	1.711	-5.351	-5.354
25 F	0.871	3.768	3.794	1.537	1.579	-2.231	-2.215
50 FL	0.000	0.000	0.000	1.765	1.814	1.766	1.814
61 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
82 F	0.500	3.199	3.222	0.883	0.907	-2.317	-2.315
103 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
104 FL	0.000	0.000	0.000	1.766	1.814	1.766	1.814
151 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
155 FL	0.500	0.685	0.690	1.766	1.814	1.081	1.124
156 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
157 ML	0.500	0.685	0.690	1.766	1.814	1.081	1.124
1 M	0.831	2.774	2.793	1.555	1.598	1.219	-1.196
75 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
7 F	0.982	17.272	17.332	1.733	1.780	-15.539	-15.612
5 M	0.973	16.984	17.102	1.717	1.764	-15.267	-15.338
11 FL	0.876	2.735	2.724	1.766	1.614	-0.940	-0.911
30 F	0.257	0.525	0.528	0.453	0.465	-0.072	-0.063
10 ML	0.869	2.055	2.069	1.766	1.814	-0.289	0.256
16 F	0.752	1.714	1.726	1.329	1.365	-0.386	-0.362
18 M	1.000	19.221	19.355	1.766	1.814	-17.456	-17.542
19 M	0.500	1.031	1.038	0.883	0.907	-0.148	-0.131
P21 M	0.247	0.339	0.341	0.437	0.449	0.098	0.107
33 M	0.500	2.064	2.079	0.883	0.907	-1.182	-1.172
43 F	0.500	2.045	2.059	0.883	0.907	-1.162	-1.153
76 M	0.753	2.401	2.417	1.329	1.366	-1.071	-1.052
P30 M	0.243	0.499	0.503	0.430	0.442	-0.069	-0.061
77 F	0.749	2.394	2.411	1.321	1.357	-1.072	-1.053
35 ML	0.500	0.685	0.690	1.766	1.814	1.081	1.124
40 FL	0.500	0.685	0.690	1.766	1.814	1.081	1.124
46 F	0.500	0.685	0.690	0.883	0.907	0.198	0.217
49 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
94 ML	0.751	1.370	1.379	1.766	1.814	0.396	0.434
73 M	0.738	1.370	1.379	1.302	1.337	-0.068	-0.042
172 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
95 FL	0.500	0.682	0.686	1.766	1.814	1.084	1.127
128 FL	0.936	2.740	2.759	1.766	1.814	-0.974	-0.945
64 FL	0.000	0.000	0.000	1.766	1.814	1.766	1.814
153 FL	0.000	0.000	0.000	1.766	1.814	1.766	1.814
66 FL	0.749	1.370	1.375	1.766	1.814	0.396	0.434
67 FL	0.000	0.000	0.000	1.766	1.814	1.766	1.814
154 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
169 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
114 FL	0.000	0.000	0.000	1.766	1.814	1.766	1.814
98 FL	0.000	0.000	0.000	1.766	1.814	1.766	1.814
170 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
171 FL	0.000	0.000	0.000	1.766	1.814	1.766	1.814
138 FL	0.000	0.000	0.000	1.766	1.814	1.766	1.814
136 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
137 FL	0.000	0.000	0.000	1.766	1.814	1.766	1.814
139 FL	0.000	0.000	0.000	1.766	1.814	1.766	1.814
174 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
173 MLU	0.000	0.000	0.000	1.766	0.000	1.766	0.000
144 FL	0.000	0.000	0.000	1.766	1.814	1.766	1.814
175 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
177 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
178 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814

Founder	Retention	%Representation		Target		Difference	
		with unk	w/o	with unk	w/o	with unk	w/o
P168 M O	0.500	0.685	0.000	0.883	0.000	0.198	0.000
T9010 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
T9011 FL	0.000	0.000	0.000	1.766	1.814	1.766	1.814
164 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814
165 FL	0.000	0.000	0.000	1.766	1.814	1.766	1.814
179 ML	0.000	0.000	0.000	1.766	1.814	1.766	1.814

GENETIC SUMMARY	LIVING DESCENDANT POPULATION		POTENTIAL	
	with unknowns	w/o	w/ unkn	w/o
Number of founders:	30	29	64	62
Mean retention:	0.644	0.649	0.885	0.889
Founder genomes surviving:	19.321	18.821	56.641	55.141
Founder Equivalents:	9.172	9.050	58.167	58.391
Founder Genome Equivalents:	7.086	6.993	56.641	55.141
Fraction of wild gene diversity retained:	0.929	0.928	0.991	0.991
Fraction of wild gene diversity lost:	0.071	0.072	0.009	0.009
Mean inbreeding coefficient:	0.063			

RHINOCEROS UNICORNIS - WORLD - 20-04-1992

ORDERED LISTS OF MEAN KINSHIP BY SEX:

Rank	MALES	MK	Known	FEMALES	MK	Known
1	22	0.0000	1.0000	50	0.0000	1.0000
2	61	0.0000	1.0000	104	0.0000	1.0000
3	103	0.0000	1.0000	64	0.0000	1.0000
4	151	0.0000	1.0000	153	0.0000	1.0000
5	156	0.0000	1.0000	67	0.0000	1.0000
6	75	0.0000	1.0000	114	0.0000	1.0000
7	49	0.0000	1.0000	98	0.0000	1.0000
8	172	0.0000	1.0000	171	0.0000	1.0000
9	154	0.0000	1.0000	138	0.0000	1.0000
10	169	0.0000	1.0000	137	0.0000	1.0000
11	170	0.0000	1.0000	139	0.0000	1.0000
12	136	0.0000	1.0000	144	0.0000	1.0000
13	174	0.0000	1.0000	T9011	0.0000	1.0000
14	175	0.0000	1.0000	165	0.0000	1.0000
15	177	0.0000	1.0000	155	0.0034	1.0000
16	178	0.0000	1.0000	40	0.0034	1.0000
17	T9010	0.0000	1.0000	95	0.0034	1.0000
18	164	0.0000	1.0000	66	0.0069	1.0000
19	175	0.0000	1.0000	159	0.0069	1.0000
20	157	0.0034	1.0000	97	0.0086	1.0000
21	35	0.0034	1.0000	11	0.0138	1.0000
22	54	0.0069	1.0000	128	0.0138	1.0000
23	125	0.0069	1.0000	T9012	0.0187	1.0000
24	150	0.0086	1.0000	79	0.0190	1.0000
25	10	0.0103	1.0000	51	0.0207	1.0000
26	69	0.0103	1.0000	122	0.0291	1.0000
27	166	0.0147	1.0000	168	0.0323	1.0000
28	96	0.0155	1.0000	29	0.0422	1.0000
29	53	0.0172	1.0000	38	0.0560	1.0000
30	42	0.0190	1.0000	131	0.0595	1.0000
31	106	0.0207	1.0000	161	0.0595	1.0000
32	129	0.0291	1.0000	133	0.0619	1.0000
33	140	0.0291	1.0000	182	0.0653	1.0000
34	160	0.0291	1.0000	89	0.0793	1.0000
35	57	0.0306	1.0000	99	0.0679	1.0000
36	176	0.0352	0.5000	31	0.1000	1.0000
37	70	0.0375	1.0000	80	0.1009	1.0000
38	32	0.0517	1.0000	130	0.1039	1.0000
39	184	0.0578	1.0000	143	0.1039	1.0000
40	126	0.0591	1.0000	45	0.1065	1.0000
41	147	0.0591	1.0000	120	0.1073	1.0000
42	T9009	0.0591	1.0000	56	0.1078	1.0000
43	134	0.0619	1.0000	55	0.1099	1.0000
44	T9013	0.0653	1.0000	183	0.1123	1.0000
45	162	0.0681	1.0000	148	0.1123	1.0000
46	115	0.0681	1.0000	34	0.1159	1.0000
47	132	0.0681	1.0000	93	0.1226	1.0000
48	145	0.0681	1.0000			
49	101	0.0793	1.0000			
50	116	0.0793	1.0000			
51	146	0.0793	1.0000			
52	180	0.0793	1.0000			
53	39	0.0957	1.0000			
54	124	0.1022	1.0000			
55	83	0.1052	1.0000			
56	87	0.1056	1.0000			
57	60	0.1086	1.0000			

Rank	MALES	MK	Known	FEMALES	MK	Known
58	71	0.1093	1.0000			
59	26	0.1095	1.0000			
60	100	0.1108	1.0000			
61	181	0.1116	1.0000			
62	41	0.1203	1.0000			
63	109	0.1211	1.0000			
64	117	0.1211	1.0000			
65	123	0.1211	1.0000			
66	135	0.1211	1.0000			
67	152	0.1211	1.0000			
68	86	0.1226	1.0000			
69	141	0.1254	1.0000			
70	173		0.0000			

GENETIC SUMMARY OF POPULATION

Descendant population mean kinship:	0.0713
Gene diversity:	0.9287
Founder Genome Equivalents:	7.0091

INDIAN RHINOCEROS Studbook
(Rhinoceros unicorinis)

Restricted to:
Locations: ASIA /
Datos: During 19/04/1991 <- date
Status: Living during 19 Apr 1991 -> 23 Apr 1992

Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
15	F	- 1948	WILD	WILD	ASSAM P	- 1948	UNK	Wild Born	INDIA		RANI	
					MYSORE	- 1956	UNK		INDIA			
21	F	????	WILD	WILD	INDIA	????	UNK	Wild Born	INDIA		LAVIE/RANI	
					TOKYOUENO	- 1961	UNK		JAPAN			
					TOKYOTAMA	1 Jan 1989	UNK		JAPAN			
22	M	????	WILD	WILD	INDIA	????	UNK	Wild Born	INDIA		TAMAO/LUPS	
					TOKYOUENO	- 1961	UNK		JAPAN			
					TOKYOTAMA	1 Jan 1989	UNK		JAPAN			
57	M	12 Sep 1971	24	25	ASSAM	12 Sep 1971	UNK	Captive Born	INDIA		KRISHNA	
					NAGOYA	2 Oct 1974	UNK		JAPAN			
61	M	????	WILD	WILD	ASSAM P	????	UNK	Wild Born	INDIA		SONTO	
					ASSAM	28 Jun 1971	UNK		INDIA			
					MYSORE	????	UNK		INDIA			
64	F	- Sep 1973	WILD	WILD	ASSAM P	3 Jan 1974	UNK	Wild Born	INDIA		RAJA/JAYA	
					ASSAM	3 Jan 1974	UNK		INDIA			
					NAGOYA	2 Oct 1974	UNK		JAPAN			
70	M	23 May 1974	24	25	ASSAM	23 May 1974	UNK	Captive Born	INDIA		LACHIT	
						23 May 1974	UNK					
					KANPUR	4 Mar 1977	UNK		INDIA			
75	M	- 1945	WILD	WILD	ASSAM P	31 Jan 1945	UNK	Wild Born	INDIA		KUSHAL	
					MADRAS	9 Jun 1953	UNK		INDIA			
94	M	1 Aug 1969	WILD	WILD	ASSAM P	1 Aug 1969	UNK	Wild Born	INDIA		MEGHNAD	
					CALCUTTA	14 Mar 1974	UNK		INDIA			
95	F	1 May 1973	WILD	WILD	ASSAM P	1 May 1973	UNK	Wild Born	INDIA		KADAMBINI	
					CALCUTTA	14 Mar 1974	UNK		INDIA			
96	M	12 Nov 1978	76	77	HYDERABAD	12 Nov 1978	UNK	Captive Born	INDIA		LADDU	
						12 Nov 1978	UNK					
99	F	- Sep 1979	WILD	WILD	NEPAL	1 Sep 1979	UNK	Wild Born	NEPAL		BHRATI	
					PEKING	10 Sep 1980	UNK		CHINA			
103	M	????	WILD	WILD	NEPAL	1 Jan 1900	UNK	Wild Born	NEPAL			
					RANGOON	27 Aug 1980	UNK		BURMA			
104	F	????	WILD	WILD	NEPAL	1 Jan 1900	UNK	Wild Born	NEPAL			
					RANGOON	27 Aug 1980	UNK		BURMA			

Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group
Data current thru: 31 Dec 1990 INTERNATIONAL

SPARKS v1.11
23 Apr 1992

INDIAN RHINOCEROS Studbook
(Rhinoceros unicorinis)

Restricted to:
Locations: ASIA /
Dates: During 19/04/1991 <= date
Status: Living during 19 Apr 1991 -> 23 Apr 1992

Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth Origin	Country	Death Date	Name	Breeder #
109	M	30 Aug 1981	41	34	STUTTGART	30 Aug 1981	UNK	Captive Born	W.GERMANY		NADIR	
					ROTTERDAM	13 Apr 1983	UNK		NETHERLND			
					SINGAPORE	25 May 1993	UNK		SINGAPORR			
114	F	- 1979	WILD	WILD	NEPAL	- 1979	UNK	Wild Born	NEPAL			
					KAT-MANDU	17 May 1983	UNK		NEPAL			
117	M	12 Jul 1983	41	34	STUTTGART	12 Jul 1983	UNK	Captive Born	W.GERMANY		KATGIN	
					YOKOHAMA	27 Aug 1985	UNK		JAPAN			
122	F	1 Oct 1982	70	128	KANPUR	1 Oct 1982	UNK	Captive Born	INDIA		RASHMI/SAM	
					YOKOHAMA	4 Dec 1985	UNK		JAPAN			
124	M	25 Jun 1985	26	99	SD-WAP	25 Jun 1985	UNK	Captive Born	U.S.A.		GURKHA	SDWAP
					SINGAPORE	26 Dec 1989	UNK		SINGAPORR			
128	F	11 Aug 1973	WILD	WILD	ASSAM P	11 Aug 1973	UNK	Wild Born	INDIA		MAYLNG	
					ASSAM	- 1977	UNK		INDIA			
					KANPUR	6 Mar 1977	UNK		INDIA			
129	M	6 Dec 1984	70	128	KANPUR	6 Dec 1984	UNK	Captive Born	INDIA		LOHIT	
140	M	17 Jun 1987	70	128	KANPUR	17 Jun 1987	UNK	Captive Born	INDIA		MOHIT	
150	M	4 Jun 1984	94	95	CALCUTTA	4 Jun 1984	UNK	Captive Born	INDIA		DEBRAJ	
151	M	????	WILD	WILD	ASSAM P	- 1983	UNK	Wild Born	INDIA		DABBU	
					DELHI	3 Feb 1983	UNK		INDIA			
153	F	- 1974	WILD	WILD	ASSAM P	- 1974	UNK	Wild Born	INDIA		NJMULI	
					NANDANKAN	8 Apr 1976	UNK		INDIA			
154	M	- 1976	WILD	WILD	ASSAM P	- 1976	UNK	Wild Born	INDIA		NANDAN	
					NANDANKAN	2 Dec 1979	UNK		INDIA			
155	F	????	WILD	WILD	ASSAM P	????	UNK	Wild Born	INDIA		KANCHI	
					PATNA	28 May 1979	UNK		INDIA			
156	M	????	WILD	WILD	ASSAM P	????	UNK	Wild Born	INDIA		KANCHA	
					PATNA	28 May 1979	UNK		INDIA			
157	M	????	WILD	WILD	INDIA	????	UNK	Wild Born	INDIA		RAJU	
					PATNA	28 Mar 1992	UNK		INDIA			
159	F	8 Jul 1988	157	155	PATNA	8 Jul 1988	UNK	Captive Born	INDIA		HARTALI	
160	M	23 Jun 1989	70	128	KANPUR	23 Jun 1989	UNK	Captive Born	INDIA		ROHIT	

INDIAN RHINOCEROS Studbook

(Rhinoceros unicorinis)

Restricted to:
Locations: ASIA /
Dates: During 19/04/1991 <- date
Status: Living during 19 Apr 1991 -> 23 Apr 1992

Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
164	M	- Oct 1989	WILD	WILD	NEPAL	- Oct 1989	UNK	Wild Born	NEPAL		KATNAK	
					SINGAPORE	7 May 1990	UNK		SINGAPORE			
165	F	- Oct 1989	WILD	WILD	NEPAL	- Oct 1989	UNK	Wild Born	NEPAL		KANCHAN	
					SINGAPORE	7 May 1990	UNK		SINGAPORE			
168	F	9 Jan 1978	24	25	ASSAM	9 Jan 1978	UNK	Captive Born	INDIA		LAKHMONI	
169	M	- 1976	WILD	WILD	ASSAM P	- 1976	UNK	Wild Born	INDIA		LAKHMAN	
					ASSAM	27 Jan 1980	UNK		INDIA			
170	M	- Feb 1980	WILD	WILD	ASSAM P	- Feb 1980	UNK	Wild Born	INDIA		JHON	
					ASSAM	23 Aug 1980	UNK		INDIA			
171	F	- Jun 1980	WILD	WILD	ASSAM P	- Jun 1980	UNK	Wild Born	INDIA		GINI	
					ASSAM	23 Aug 1980	UNK		INDIA			
172	M	- 1972	WILD	WILD	ASSAM P	- 1972	UNK	Wild Born	INDIA		GANESH	
					ASSAM	15 Jul 1982	UNK		INDIA			
173	M	11 May 1987	UNK	UNK	ASSAM	11 May 1987	UNK	Captive Born	INDIA		BISHNU	
174	M	- Jan 1987	WILD	WILD	ASSAM P	- Jan 1987	UNK	Wild Born	INDIA		BATUL	
					ASSAM	25 Aug 1987	UNK		INDIA			
175	M	- Mar 1988	WILD	WILD	ASSAM P	- Mar 1988	UNK	Wild Born	INDIA		RAMU	
					ASSAM	2 Sep 1988	UNK		INDIA			
176	M	30 Mar 1989	UNK	168	ASSAM	30 Mar 1989	UNK	Captive Born	INDIA		MOHESH	
177	M	1 Jul 1988	WILD	WILD	ASSAM P	1 Jul 1988	UNK	Wild Born	INDIA		JADU	
					ASSAM	26 Jul 1989	UNK		INDIA			
178	M	- Jan 1989	WILD	WILD	ASSAM P	- 1989	UNK	Wild Born	INDIA		MADU	
					ASSAM	26 Jul 1989	UNK		INDIA			
179	M	- May 1990	WILD	WILD	ASSAM P	- May 1990	UNK	Wild Born	INDIA		PRADIP	
					ASSAM	20 Aug 1990	UNK		INDIA			

TOTALS: 30.15.0 (45)

```
                              Age Pyramid Report
Restricted to:              INDIAN RHINOCEROS Studbook
 Locations: ASIA     /
 Dates: As of End of 19/04/1991 <= date
================================================================================
Taxon Name: RHINOCEROS UNICORINIS
================================================================================
Age                                Males|Females
---             N =  24          ---------------             N =  12
   47-                                 X|
   46-                                  |
   45-                                  |
   44-                                  |X
   43-                                  |
   42-                                  |
   41-                                  |
   40-                                  |
   39-                                  |
   38-                                  |
   37-                                  |
   36-                                  |
   35-                                  |
   34-                                  |
   33-                                  |
   32-                                  |
   31-                                  |
   30-                                  |
   29-                                  |
   28-                                  |
   27-                                  |
   26-                                  |
   25-                                  |
   24-                                  |
   23-                                  |
   22-                                 X|
   21-                                  |
   20-                                XX|
   19-                                  |
   18-                                  |XXXX
   17-                                 X|
   16-                                XX|
   15-                                  |
   14-                                  |X
   13-                                 X|X
   12-                                 X|X
   11-                                  |X
   10-                                 X|
    9-                                  |X
    8-                                 X|
    7-                                XX|
    6-                                 X|
    5-                                 X|
    4-                               XXX|
    3-                               XXX|X
    2-                                XX|X
    1-                                 X|
    0-                                  |
- - - - - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - - -
          32  28  24  20  16  12  8   4       4   8   12  16  20  24  28  32
                                   Number of Animals
```

```
 X >>> Specimens of known sex...
 ? >>> Specimens of unknown sex...
     6 Male Specimens of unknown age...
     3 Female Specimens of unknown age...
```

```
                                     Age Pyramid Report                     Report Date:
                              INDIAN RHINOCEROS Studbook                    23 Apr 1992
=================================================================================================
Taxon Name: RHINOCEROS UNICORINIS
                                                                                 Page    2
=================================================================================================
Age  Studbook Numbers >>>  Male
---  ----------------
 47 |      75
 46 |
 45 |
 44 |
 43 |
 42 |
 41 |
 40 |
 39 |
 38 |
 37 |
 36 |
 35 |
 34 |
 33 |
 32 |
 31 |
 30 |
 29 |
 28 |
 27 |
 26 |
 25 |
 24 |
 23 |
 22 |      94
 21 |
 20 |      57      172
 19 |
 18 |
 17 |      70
 16 |     154      169
 15 |
 14 |
 13 |      96
 12 |     170
 11 |
 10 |     109
  9 |
  8 |     117
  7 |     129      150
  6 |     124
  5 |     174
  4 |     140      173      175
  3 |     176      177      178
  2 |     160      164
  1 |     179
  0 |
UNK |      22       61      103      152      156      157
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Total=   30

Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group                   SPARKS v1.11
```

```
                              Age Pyramid Report                          Report Date:
                          INDIAN RHINOCEROS Studbook                       23 Apr 1992
========================================================================================
Taxon Name: RHINOCEROS UNICORINIS                                          Page    3
========================================================================================
Age  Studbook Numbers >>>  Female
---  ----------------
 47|
 46|
 45|
 44|     11
 43|
 42|
 41|
 40|
 39|
 38|
 37|
 36|
 35|
 34|
 33|
 32|
 31|
 30|
 29|
 28|
 27|
 26|
 25|
 24|
 23|
 22|
 21|
 20|
 19|
 18|     64      95      128      153
 17|
 16|
 15|
 14|    168
 13|    114
 12|     98
 11|    171
 10|
  9|    122
  8|
  7|
  6|
  5|
  4|
  3|    159
  2|    165
  1|
  0|
UNK|     21     104     155
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Total-  15

Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group              SPARKS v1.11
```

```
                                 Fecundity & Mortality Report
 Restricted to:                   INDIAN RHINOCEROS Studbook
  Locations: ASIA        /
 ===================================================================================
 Taxon Name: RHINOCEROS UNICORINIS
 ===================================================================================

                      Fecundity [Mx]...                   Mortality [Qx]...
  Age Class       Male    N       Female    N          Male    N      Female    N
  ---------       ----   ---      ------   ---         ----   ---     ------   ---

     0- 1         0.00   38.0       0.00   26.5        0.01   40.0      0.05   32.6
     1- 2         0.00   35.6       0.00   21.8        0.03   36.7      0.00   22.2
     2- 3         0.00   33.2       0.00   19.3        0.00   32.3      0.00   19.6
     3- 4         0.00   29.2       0.00   17.6        0.00   29.2      0.00   17.6
     4- 5         0.00   26.5       0.00   16.0        0.04   24.7      0.00   15.3
     5- 6         0.00   20.5       0.00   15.4        0.00   20.5      0.00   15.0
     6- 7         0.00   19.8       0.00   15.9        0.00   19.8      0.00   15.8
     7- 8         0.00   18.3       0.06   15.2        0.00   18.1      0.00   15.2
     8- 9         0.16   17.1       0.05   15.6        0.00   17.1      0.00   15.8
     9-10         0.05   17.0       0.06   14.6        0.00   17.0      0.00   14.6
    10-11         0.05   16.7       0.00   14.0        0.00   16.7      0.00   14.0
    11-12         0.00   15.7       0.19   13.8        0.07   15.0      0.00   12.9
    12-13         0.00   14.2       0.00   11.6        0.00   14.2      0.00   11.6
    13-14         0.07   13.5       0.08   10.3        0.00   13.5      0.00   10.3
    14-15         0.07   13.0       0.09    9.5        0.00   13.0      0.00   10.5
    15-16         0.14   13.0       0.18    9.9        0.00   13.0      0.00    9.0
    16-17         0.00   11.4       0.00    9.0        0.00   10.6      0.00    9.0
    17-18         0.00    9.9       0.19    9.0        0.00    9.9      0.00    9.0
    18-19         0.10    9.0       0.00    7.6        0.00    9.0      0.00    7.6
    19-20         0.00    9.0       0.00    4.6        0.00    9.0      0.25    4.0
    20-21         0.00    7.3       0.22    4.0        0.34    5.9      0.00    4.0
    21-22         0.00    5.0       0.00    3.4        0.00    5.0      0.33    3.0
    22-23         0.00    4.7       0.00    3.0        0.00    4.7      0.00    3.0
    23-24         0.00    4.0       0.29    3.0        0.00    4.0      0.00    3.0
    24-25         0.00    4.0       0.00    2.2        0.00    3.8      0.50    2.0
    25-26         0.00    4.0       0.00    2.0        0.00    4.0      0.00    2.0
    26-27         0.00    3.4       0.00    2.0        0.33    3.0      0.00    2.0
    27-28         0.39    2.3       0.43    2.0        0.50    2.0      0.00    2.0
    28-29         0.00    2.0       0.00    2.0        0.00    2.0      0.00    2.0
    29-30         0.00    2.0       0.00    2.0        0.00    2.0      0.00    2.0
    30-31         0.44    2.0       0.00    2.0        0.00    2.0      0.00    2.0
    31-32         0.00    2.0       0.00    2.0        0.00    2.0      0.00    2.0
    32-33         0.00    2.0       0.00    2.0        0.00    2.0      0.00    2.0
    33-34         0.00    2.0       0.00    2.0        0.00    2.0      0.00    2.0
    34-35         0.44    2.0       0.00    2.0        0.00    2.0      0.00    2.0
    35-36         0.00    2.0       0.00    1.2        0.00    2.0      1.00    1.0
    36-37         0.00    2.0       0.00    1.0        0.00    2.0      0.00    1.0
    37-38         0.00    2.0       0.00    1.0        0.00    2.0      0.00    1.0
    38-39         0.00    1.2       0.00    1.0        1.00    1.0      0.00    1.0
    39-40         0.00    1.0       0.00    1.0        0.00    1.0      0.00    1.0
    40-41         0.00    1.0       0.00    1.0        0.00    1.0      0.00    1.0
    41-42         0.00    1.0       0.00    1.0        0.00    1.0      0.00    1.0
    42-43         0.00    1.0       0.00    1.0        0.00    1.0      0.00    1.0
    43-44         0.00    1.0       0.00    1.0        0.00    1.0      0.00    1.0
    44-45         0.00    1.0       0.00    0.2        0.00    1.0      0.00    0.2
    45-46         0.00    1.0       0.00    0.0        0.00    1.0      0.00    0.0
    46-47         0.00    1.0       0.00    0.0        0.00    1.0      0.00    0.0
    47-48         0.00    0.2       0.00    0.0        0.00    0.2      0.00    0.0
    48-49         0.00    0.0       0.00    0.0        0.00    0.0      0.00    0.0
    49-50         0.00    0.0       0.00    0.0        0.00    0.0      0.00    0.0
```

```
      T  = 17.805     T  = 16.113      30 day mortality:  3%
      Ro =  0.806     Ro =  1.253         (2 out of 65)
      lambda-0.99     lambda=1.01
      r  = -0.012     r  -  0.014

   14 birth events to known age parents tabulated for Mx...plus...
     10 births to dams of unknown age...
      1 births to UNK or MULT dams...
      8 births to sires of unknown age...
      2 births to UNK or MULT sires...

   14 death events of known age tabulated for Qx...

 WARNING: Values with small sample sizes (N) warrant less confidence...
```

```
                             Fecundity & Mortality Report
 Restricted to:               INDIAN RHINOCEROS Studbook
  Locations: ASIA      /
  Dates: During 01/01/1981 <  date
=====================================================================================
 Taxon Name: RHINOCEROS UNICORINIS
-------------------------------------------------------------------------------------

                      Fecundity [Mx]...                    Mortality [Qx]...
  Age Class      Male    N      Female    N          Male    N      Female    N
  ---------      ----   ---     ------   ---         ----   ---     ------   ---

     0- 1        0.00  14.2      0.00    6.1         0.00  14.2      0.14    7.1
     1- 2        0.00  14.9      0.00    4.9         0.07  15.1      0.00    4.9
     2- 3        0.00  14.1      0.00    6.6         0.00  14.1      0.00    6.6
     3- 4        0.00  11.2      0.00    6.8         0.00  11.2      0.00    6.8
     4- 5        0.00   8.7      0.00    6.0         0.00   8.7      0.00    6.0
     5- 6        0.00   8.3      0.00    6.1         0.00   8.3      0.00    6.1
     6- 7        0.00   8.2      0.00    7.0         0.00   8.2      0.00    7.0
     7- 8        0.00   7.3      0.00    8.8         0.00   7.3      0.00    8.8
     8- 9        0.14   6.0      0.00   10.0         0.00   6.0      0.00   10.0
     9-10        0.00   8.6      0.07    9.6         0.00   8.6      0.00    9.6
    10-11        0.10   8.6      0.00    9.0         0.00   8.6      0.00    9.0
    11-12        0.00   8.3      0.24    8.8         0.13   7.6      0.00    7.9
    12-13        0.00   7.2      0.00    6.6         0.00   7.2      0.00    6.6
    13-14        0.13   6.4      0.13    5.3         0.00   6.4      0.00    5.3
    14-15        0.14   6.0      0.00    4.3         0.00   6.0      0.00    4.3
    15-16        0.14   6.0      0.18    4.0         0.00   6.0      0.00    4.0
    16-17        0.00   4.6      0.00    4.1         0.00   4.6      0.00    4.1
    17-18        0.00   4.0      0.14    5.0         0.00   4.0      0.00    5.0
    18-19        0.20   4.1      0.00    3.7         0.00   4.1      0.00    3.7
    19-20        0.00   5.0      0.00    1.7         0.00   5.0      0.84    1.2
    20-21        0.00   3.5      0.00    2.0         0.34   2.9      0.00    2.0
    21-22        0.00   2.0      0.00    1.4         0.00   2.0      1.00    1.0
    22-23        0.00   1.7      0.00    1.0         0.00   1.7      0.00    1.0
    23-24        0.00   1.0      0.00    1.0         0.00   1.0      0.00    1.0
    24-25        0.00   1.0      0.00    0.3         0.00   1.0      0.00    0.0
    25-26        0.00   1.0      0.00    0.0         0.00   1.0      0.00    0.0
    26-27        0.00   0.4      0.00    0.0         0.00   0.0      0.00    0.0
    27-28        0.00   0.0      0.00    0.0         0.00   0.0      0.00    0.0
    28-29        0.00   0.0      0.00    0.0         0.00   0.0      0.00    0.0

               T   = 13.306    T   = 13.211     30 day mortality:  5%
               Ro =   0.717    Ro =   0.654        (1 out of 21)
               lambda=0.98     lambda 0.97
               r   = -0.025    r   = -0.032

           6 birth events to known age parents tabulated for Mx...plus...
             2 births to dams of unknown age...
             1 births to UNK or MULT dams...
             2 births to sires of unknown age...
             2 births to UNK or MULT sires...

           8 death events of known age tabulated for Qx...

 WARNING: Values with small sample sizes (N) warrant less confidence...

 Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group           SPARKS v1.11
 Data current thru: 31 Dec 1990 INTERNATIONAL                             21 Apr 1992
```

```
                          Fecundity & Mortality Report
Restricted to:             INDIAN RHINOCEROS Studbook
 Locations: ASIA     /
 Dates: During 01/01/1982 <= date
==============================================================================
Taxon Name: RHINOCEROS UNICORINIS
------------------------------------------------------------------------------

                  Fecundity [Mx]...              Mortality [Qx]...
 Age Class      Male    N     Female    N       Male    N     Female    N
 ---------      ----   ---    ------   ---      ----   ---    ------   ---
   0- 1         0.00  13.4     0.00    5.7      0.00  13.4     0.15    6.7
   1- 2         0.00  13.2     0.00    3.7      0.00  13.2     0.00    3.7
   2- 3         0.00  13.3     0.00    4.2      0.00  13.3     0.00    4.2
   3- 4         0.00  11.0     0.00    5.8      0.00  11.0     0.00    5.8
   4- 5         0.00   8.7     0.00    6.0      0.00   8.7     0.00    6.0
   5- 6         0.00   6.3     0.00    6.0      0.00   6.3     0.00    6.0
   6- 7         0.00   7.8     0.00    6.1      0.00   7.8     0.00    6.1
   7- 8         0.00   6.6     0.00    6.2      0.00   6.6     0.00    6.2
   8- 9         0.15   6.0     0.00    8.6      0.00   6.0     0.00    8.6
   9-10         0.00   6.0     0.08    9.6      0.00   6.0     0.00    9.6
  10-11         0.11   8.2     0.00    9.0      0.00   8.2     0.00    9.0
  11-12         0.00   7.7     0.26    8.8      0.14   7.0     0.00    7.9
  12-13         0.00   6.8     0.00    6.6      0.00   6.8     0.00    6.6
  13-14         0.14   6.4     0.14    5.3      0.00   6.4     0.00    5.3
  14-15         0.15   6.0     0.00    4.3      0.00   6.0     0.00    4.3
  15-16         0.15   6.0     0.19    4.0      0.00   6.0     0.00    4.0
  16-17         0.00   4.6     0.00    4.0      0.00   4.6     0.00    4.0
  17-18         0.00   3.9     0.00    4.1      0.00   3.9     0.00    4.1
  18-19         0.00   3.1     0.00    3.6      0.00   3.1     0.00    3.6
  19-20         0.00   4.1     0.00    0.6      0.00   4.1     1.00    0.1
  20-21         0.00   3.5     0.00    1.2      0.34   2.9     0.00    1.2
  21-22         0.00   2.0     0.00    1.4      0.00   2.0     1.00    1.0
  22-23         0.00   1.7     0.00    1.0      0.00   1.7     0.00    1.0
  23-24         0.00   1.0     0.00    1.0      0.00   1.0     0.00    1.0
  24-25         0.00   1.0     0.00    0.3      0.00   1.0     0.00    0.0
  25-26         0.00   1.0     0.00    0.0      0.00   1.0     0.00    0.0
  26-27         0.00   0.4     0.00    0.0      0.00   0.0     0.00    0.0
  27-28         0.00   0.0     0.00    0.0      0.00   0.0     0.00    0.0
  28-29         0.00   0.0     0.00    0.0      0.00   0.0     0.00    0.0

             T  = 11.915    T  = 12.313    30 day mortality:  5%
             Ro =  0.638    Ro =  0.570       (1 out of 20)
             lambda=0.96    lambda=0.96
             r  = -0.038    r  = -0.046

         5 birth events to known age parents tabulated for Mx...plus...
           2 births to dams of unknown age...
           1 births to UNK or MULT dams...
           2 births to sires of unknown age...
           2 births to UNK or MULT sires...

         7 death events of known age tabulated for Qx...

 WARNING: Values with small sample sizes (N) warrant less confidence...

Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group     SPARKS v1.11
Data current thru: 31 Dec 1990 INTERNATIONAL                        20 Apr 1992
```

FOUNDER ANALYSIS - *RHINOCEROS UNICORINIS* - ASIA - 23/04/1992

Founder representation in each living animal:
  Founders listed across top, descendants down side.
  Founder calculations omit UNKNOWNs.

Founders:

```
      21        22        24        25        61        82       103
     104       151       155       156       157        75         7
       5        11        18        76        77        94       172
      95       128        64       153       154       169       114
      98       170       171       174       175       177       178
     164       165       179
```

Founder contributions:

```
  0.0000    0.0000    2.8750    2.7500    0.0000    0.1250    0.0000
  0.0000    0.0000    0.5000    0.0000    0.5000    0.0000    0.8750
  1.3750    0.0000    0.5000    0.5000    0.5000    0.5000    0.0000
  0.5000    2.0000    0.0000    0.0000    0.0000    0.0000    0.0000
  0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
  0.0000    0.0000    0.0000
```

Fractional contributions:

```
  0.0000    0.0000    0.2130    0.2037    0.0000    0.0093    0.0000
  0.0000    0.0000    0.0370    0.0000    0.0370    0.0000    0.0648
  0.1019    0.0000    0.0370    0.0370    0.0370    0.0370    0.0000
  0.0370    0.1481    0.0000    0.0000    0.0000    0.0000    0.0000
  0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
  0.0000    0.0000    0.0000
```

Number of living descendants:

```
       0         0         9         8         0         1         0
       0         0         1         0         1         0         3
       3         0         2         1         1         1         0
       1         4         0         0         0         0         0
       0         0         0         0         0         0         0
       0         0         0
```

GENE DROP - *RHINOCEROS UNICORINIS* - ASIA - 23/04/1992

Studbook	Sire	Dam	Status (cap=alive)	Prop. genome living desc.	unique among all living
21 F	WILD	WILD	F		1.0000
22 M	WILD	WILD	F		1.0000
24 M	WILD	WILD	f		
25 F	WILD	WILD	f		
61 M	WILD	WILD	F		1.0000
82 F	WILD	WILD	f		
103 M	WILD	WILD	F		1.0000
104 F	WILD	WILD	F		1.0000
151 M	WILD	WILD	F		1.0000
155 F	WILD	WILD	F		0.5000
156 M	WILD	WILD	F		1.0000
157 M	WILD	WILD	F		0.5000
75 M	WILD	WILD	F		1.0000
7 F	WILD	WILD	f		
5 M	WILD	WILD	f		
11 F	WILD	WILD	F		1.0000
18 M	WILD	WILD	f		
17 F	5	7	d		
26 M	5	7	d		
76 M	WILD	WILD	f		
29 F	24	82	d		
77 F	WILD	WILD	f		
34 F	5	17	d		
41 M	18	17	d		
94 M	WILD	WILD	F		0.5000
57 M	24	35	A	0.2395	0.2395
172 M	WILD	WILD	F		1.0000
95 F	WILD	WILD	F		0.5000
128 F	WILD	WILD	F		0.0625
64 F	WILD	WILD	F		1.0000
153 F	WILD	WILD	F		1.0000
70 M	24	25	A	0.0130	0.0130
154 M	WILD	WILD	F		1.0000
169 M	WILD	WILD	F		1.0000
168 F	24	25	A	0.1140	0.1140
99 F	26	29	d		
96 M	76	77	A	1.0000	1.0000
114 F	WILD	WILD	F		1.0000
98 F	WILD	WILD	F		1.0000
170 M	WILD	WILD	F		1.0000
171 F	WILD	WILD	F		1.0000
109 M	41	34	A	0.2745	0.2745
122 F	70	128	A	0.0560	0.0000
117 M	41	34	A	0.2655	0.2655
150 M	94	95	A	1.0000	0.0000
129 M	70	128	A	0.0635	0.0000
124 M	26	99	A	0.4270	0.4270
174 M	WILD	WILD	F		1.0000
173 M	UNK	UNK	U		1.0000
140 M	70	128	A	0.0615	0.0000
175 M	WILD	WILD	F		1.0000
177 M	WILD	WILD	F		1.0000
159 F	157	155	A	1.0000	0.0000
178 M	WILD	WILD	F		1.0000
P168 M	UNK	UNK	u		
176 M	P168	168	A	0.5000	0.5000
160 M	70	128	A	0.0600	0.0000
164 M	WILD	WILD	F		1.0000

```
     165 F     WILD      WILD  F                              1.0000
     179 M     WILD      WILD  F                              1.0000

  ----------------------------------------------      --------------

    40 Founders      14 Living descendants      60 In total pedigree

 --------------------------------- ----------------------   ------------
```

FOUNDER ALLELE REPRESENTATION

Founder	Retention	%Representation		Target		Difference	
		with unk	w/o	with unk	w/o	with unk	w/o
21 FL	0.000	0.000	0.000	2.778	2.898	2.778	2.898
22 ML	0.000	0.000	0.000	2.778	2.898	2.778	2.898
24 M	0.857	20.486	21.244	2.493	2.601	-17.993	-18.643
25 F	0.868	19.657	20.385	2.411	2.516	-17.246	-17.869
61 ML	0.000	0.000	0.000	2.778	2.898	2.778	2.898
62 F	0.131	0.932	0.967	0.362	0.375	-0.570	-0.588
103 ML	0.000	0.000	0.000	2.778	2.898	2.778	2.898
104 FL	0.000	0.000	0.000	2.778	2.898	2.778	2.898
151 ML	0.000	0.000	0.000	2.778	2.898	2.778	2.898
155 FL	0.500	3.571	3.704	2.778	2.898	-0.794	-0.805
156 ML	0.000	0.000	0.000	2.778	2.898	2.778	2.898
157 ML	0.500	3.571	3.704	2.778	2.898	-0.794	-0.805
79 ML	0.000	0.000	0.000	2.778	2.898	2.778	2.898
7 F	0.527	6.325	6.559	1.464	1.527	-4.861	-5.032
5 M	0.701	9.746	10.107	1.946	2.030	-7.801	-8.077
11 FL	0.000	0.000	0.000	2.778	2.898	2.778	2.898
18 M	0.350	3.566	3.700	1.054	1.100	-2.514	-2.600
75 M	0.500	3.571	3.704	1.389	1.449	-2.183	2.255
77 F	0.500	3.571	3.704	1.389	1.449	-2.183	-2.255
94 ML	0.500	3.571	3.704	2.778	2.898	-0.794	-0.805
172 ML	0.000	0.000	0.000	2.778	2.898	2.778	2.898
93 FL	0.500	3.571	3.704	2.778	2.898	-0.794	-0.805
128 FL	0.938	14.285	14.815	2.778	2.898	-11.506	-11.917
64 FL	0.000	0.000	0.000	2.778	2.898	2.778	2.898
159 FL	0.000	0.000	0.000	2.778	2.898	2.778	2.898
154 ML	0.000	0.000	0.000	2.778	2.898	2.778	2.898
169 ML	0.000	0.000	0.000	2.778	2.898	2.778	2.898
114 FL	0.000	0.000	0.000	2.778	2.898	2.778	2.898
98 FL	0.000	0.000	0.000	2.778	2.898	2.778	2.898
170 ML	0.000	0.000	0.000	2.778	2.898	2.778	2.898
171 FL	0.000	0.000	0.000	2.778	2.898	2.778	2.898
174 ML	0.000	0.000	0.000	2.778	2.898	2.778	2.898
173 MLU	0.000	0.000	0.000	2.778	0.000	2.778	0.000
175 ML	0.000	0.000	0.000	2.778	2.898	2.778	2.898
177 ML	0.000	0.000	0.000	2.778	2.898	2.778	2.898
178 ML	0.000	0.000	0.000	2.778	2.898	2.778	2.898
P168 M U	0.500	3.571	0.000	1.389	0.000	-2.183	0.000
164 ML	0.000	0.000	0.000	2.778	2.898	2.778	2.898
165 FL	0.000	0.000	0.000	2.778	2.898	2.778	2.898
179 ML	0.000	0.000	0.000	2.778	2.898	2.778	2.898

GENETIC SUMMARY	LIVING DESCENDANT POPULATION		POTENTIAL	
	with unknowns	w/o	w/ unkn	w/o
Number of founders:	14	13	40	38
Mean retention:	0.567	0.572	0.900	0.908
Founder genomes surviving:	7.941	7.441	36.003	34.503
Founder Equivalents:	8.013	7.527	37.859	35.087
Founder Genome Equivalents:	5.176	4.877	36.003	34.503
Fraction of wild gene diversity retained:	0.903	0.897	0.986	0.986
Fraction of wild gene diversity lost:	0.097	0.103	0.014	0.014
Mean inbreeding coefficient:	0.063			

RHINOCEROS UNICORINIS - ASIA - 23/04/1992

ORDERED LISTS OF MEAN KINSHIP BY SEX:

Rank	MALES	MK	Known	FEMALES	MK	Known
1	22	0.0000	1.0000	21	0.0000	1.0000
2	61	0.0000	1.0000	104	0.0000	1.0000
3	101	0.0000	1.0000	11	0.0000	1.0000
4	151	0.0000	1.0000	64	0.0000	1.0000
5	156	0.0000	1.0000	153	0.0000	1.0000
6	75	0.0000	1.0000	114	0.0000	1.0000
7	172	0.0000	1.0000	98	0.0000	1.0000
8	154	0.0000	1.0000	171	0.0000	1.0000
9	169	0.0000	1.0000	165	0.0000	1.0000
10	170	0.0000	1.0000	155	0.0185	1.0000
11	174	0.0000	1.0000	95	0.0185	1.0000
12	175	0.0000	1.0000	159	0.0370	1.0000
13	177	0.0000	1.0000	128	0.0741	1.0000
14	178	0.0000	1.0000	168	0.1219	1.0000
15	164	0.0000	1.0000	122	0.1354	1.0000
16	179	0.0000	1.0000			
17	157	0.0165	1.0000			
18	94	0.0185	1.0000			
19	96	0.0370	1.0000			
20	150	0.0370	1.0000			
21	124	0.0799	1.0000			
22	109	0.0822	1.0000			
23	117	0.0822	1.0000			
24	57	0.1227	1.0000			
25	129	0.1354	1.0000			
26	140	0.1354	1.0000			
27	160	0.1354	1.0000			
28	176	0.1505	0.5000			
29	70	0.1597	1.0000			
30	173		0.0000			

GENETIC SUMMARY OF POPULATION

Descendant population mean kinship:	0.1027
Gene diversity:	0.8973
Founder Genome Equivalents:	4.8680

INDIAN RHINOCEROS Studbook
(Rhinoceros unicorinis)

Restricted to:
Locations: EUROPE /
Dates: During 19/04/1992 <= date
Status: Living during 19 Apr 1992 -> 20 Apr 1992

Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
31	F	12 Jun 1964	5	7	BASEL	12 Jun 1964	UNK	Captive Born	SWITZRLND		MIRES	
					BERLIN W	6 May 1975	UNK		W.GERMANY			
32	M	11 Aug 1964	5	16	HAMBURG	11 Aug 1964	UNK	Captive Born	W.GERMANY		GAUHATI	
					BERLIN W	5 Aug 1965	UNK		W.GERMANY			
34	F	25 Aug 1965	5	17	BASEL	25 Aug 1965	UNK	Captive Born	SWITZRLND		WANDA	
					STUTTGART	24 Oct 1973	UNK		W.GERMANY			
38	F	9 Apr 1967	18	16	HAMBURG	9 Apr 1967	UNK	Captive Born	W.GERMANY		SHITA	
						9 Apr 1967	UNK					
39	M	7 Jul 1967	18	7	BASEL	7 Jul 1967	UNK	Captive Born	SWITZRLND		PANDUR	
					HAMBURG	5 Sep 1968	UNK		W.GERMANY			
40	F	- May 1967	WILD	WILD	NEPAL	- May 1967	UNK	Wild Born	NEPAL		KUMARI	
					BERLIN TP	1 Aug 1967	UNK		E.GERMANY			
41	M	22 Dec 1967	18	17	BASEL	22 Dec 1967	UNK	Captive Born	SWITZRLND		PURI	
					STUTTGART	3 Jun 1969	UNK		W.GERMANY			
42	M	13 Feb 1968	1	11	MYSORE	13 Feb 1968	UNK	Captive Born	INDIA		MYSORE	
					BERLIN TP	24 Apr 1971	UNK		E.GERMANY			
51	F	27 Jan 1971	33	43	DELHI	27 Jan 1971	UNK	Captive Born	INDIA		ROOPA	
					WHIPSNADE	6 Feb 1973	UNK		ENGLAND			
55	F	11 Aug 1971	18	17	BASEL	11 Aug 1971	UNK	Captive Born	SWITZRLND		TUTUMA	
					ANTWERP	5 Sep 1972	UNK		BELGIUM			
56	F	24 Aug 1971	19	7	BASEL	24 Aug 1971	UNK	Captive Born	SWITZRLND		TANAYA	
						24 Aug 1971	UNK					
60	M	4 Apr 1972	18	31	BERLIN W	4 Apr 1972	UNK	Captive Born	W.GERMANY		KUMAR	
					WHIPSNADE	26 Mar 1976	UNK		ENGLAND			
86	M	21 Sep 1977	41	34	STUTTGART	21 Sep 1977	UNK	Captive Born	W.GERMANY		DVITYJA	
					DVURKRALV	12 Aug 1980	UNK		CZECHOSLO			
93	F	13 Sep 1979	41	34	STUTTGART	13 Sep 1979	UNK	Captive Born	W.GERMANY		NUMA	
					DVURKRALV	22 Jul 1981	UNK		CZECHOSLO			
97	F	9 Jan 1979	94	23	CALCUTTA	9 Jan 1979	UNK	Captive Born	INDIA			
						9 Jan 1979	UNK					
					KOLN	10 Mar 1986	UNK		W.GERMANY			
100	M	11 Jan 1980	18	56	BASEL	11 Jan 1980	UNK	Captive Born	SWITZRLND		CHITAWAN	
						11 Jan 1980	UNK					

INDIAN RHINOCEROS Studbook
(Rhinoceros unicorinis)

Restricted to:
 Locations: EUROPE /
 Dates: During 19/04/1992 <= date
 Status: Living during 19 Apr 1992 -> 20 Apr 1992

```
==========================================================================================================================
Stud # | Sex | Birth Date | Sire  | Dam   | Location | Date        | Local ID | Birth-Origin  Country   Death-Date  Name       Breeder #
--------------------------------------------------------------------------------------------------------------------------
  110    F    16 Jan 1982    18     56  BASEL      16 Jan 1982    UNK      Captive Born  SWITZRLND              ELLORA

  113    F     9 Aug 1982    73     55  ANTWERP     9 Aug 1982    UNK      Captive Born  BELGIUM                JOHANNA

  115    M       ????        60     51  WHIPSNADE   9 Mar 1983    UNK      Captive Born  ENGLAND                BHEEMA
                                        ANTWERP     2 Oct 1985    UNK                    BELGIUM

  123    M    29 Jan 1985    41     34  STUTTGART  29 Jan 1985    UNK      Captive Born  W.GERMANY              BRUNO
                                        KOLN        9 Dec 1987    UNK                    W.GERMANY

  132    M     9 Aug 1986    60     51  WHIPSNADE   9 Aug 1986    UNK      Captive Born  ENGLAND                YODHA
                                        CHESTER     2 Dec 1987    UNK                    ENGLAND

  134    M    24 Oct 1986    73     55  ANTWERP    24 Oct 1986    UNK      Captive Born  BELGIUM                NICO
                                        ROTTERDAM   9 Oct 1990    UNK                    NETHERLND

  135    M    24 Dec 1986    41     34  STUTTGART  24 Dec 1986    UNK      Captive Born  W.GERMANY              NOEL
                                        NURNBERG    - Dec 1989    UNK                    W.GERMANY

  141    M     4 Nov 1987    96     93  DVURKRALV   4 Nov 1987    UNK      Captive Born  CZECHOSLO              NIM
                                        LIBEREC     9 Nov 1989    UNK                    CZECHOSLO

  144    F     - Dec 1987  WILD   WILD  NEPAL       - Dec 1987    UNK      Wild Born     NEPAL                  NARAJANI
                                        BERLIN W   15 May 1988    UNK                    W.GERMANY

  145    M     8 May 1988    60     51  WHIPSNADE   8 May 1988    UNK      Captive Born  ENGLAND                ROPEN
                                        DVURKRALV  16 Nov 1990    UNK                    CZECHOSLO

  148    F     4 Dec 1988   100     56  BASEL       4 Oct 1988    UNK      Captive Born  SWITZRLND              NAST
                                        MUNICH     11 Jul 1990    UNK                    W.GERMANY

  152    M    27 Nov 1988    41     34  STUTTGART  27 Nov 1988    UNK      Captive Born  W.GERMANY              NIKOLAUS
                                        MUNICH     12 Jun 1990    UNK                    W.GERMANY

  162    M     2 Oct 1989    60     51  WHIPSNADE   2 Oct 1989    UNK      Captive Born  ENGLAND                BARDIA

  166    M     1 Jan 1990    42     40  BERLIN TP   1 Jan 1990    UNK      Captive Born  E.GERMANY              BELUR

  181    M    31 May 1990   100    110  BASEL      31 May 1990    UNK      Captive Born  SWITZRLND              NANDI

  183    F    23 Oct 1990   100     56  BASEL      23 Oct 1990    UNK      Captive Born  SWITZRLND              NILGIRI
==========================================================================================================================
TOTALS: 18.14.0 (32)
```

Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group
Data current thru: 31 Dec 1990 INTERNATIONAL

SPARKS v1.11
20 Apr 1992

```
                               Age Pyramid Report
Restricted to:             INDIAN RHINOCEROS Studbook
 Locations: EUROPE    /
 Dates: As of End of 19/04/1992 <= date
---------------------------------------------------------------------------------
Taxon Name: RHINOCEROS UNICORINIS
---------------------------------------------------------------------------------
Age                                 Males Females
---             N =  17           ---------------         N -  14
 27-                                    X|X
 26-                                     |X
 25-                                     |X
 24-                                  XXX|X
 23-                                     |
 22-                                     |
 21-                                     |X
 20-                                    X|XX
 19-                                     |
 18-                                     |
 17-                                     |
 16-                                     |
 15-                                     |
 14-                                    X|
 13-                                     |X
 12-                                    X|X
 11-                                     |
 10-                                     |X
  9-                                     |X
  8-                                     |
  7-                                    X|
  6-                                     |
  5-                                  XXX|
  4-                                    X|X
  3-                                   XX|X
  2-                                   XX|
  1-                                    X|X
  0-                                     |
 - - - - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - - -
        32  28  24  20  16  12   8   4       4   8   12  16  20  24  28  32
                                 Number of Animals

 X >>> Specimens of known sex...
 ? >>> Specimens of unknown sex...
    1 Male Specimens of unknown age...

Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group        SPARKS v1.11
Data current thru: 31 Dec 1990 INTERNATIONAL                           20 Apr 1992
```

```
                                    Age Pyramid Report                        Report Date:
                              INDIAN RHINOCEROS Studbook                       20 Apr 1992
===========================================================================================
Taxon Name: RHINOCEROS UNICORNIS                                              Page     2
===========================================================================================
Age  Studbook Numbers >>>  Male
---  ----------------
 27|      32
 26|
 25|
 24|      39      41      42
 23|
 22|
 21|
 20|      60
 19|
 18|
 17|
 16|
 15|
 14|      86
 13|
 12|     100
 11|
 10|
  9|
  8|
  7|     123
  6|
  5|     132     134     135
  4|     141
  3|     145     152
  2|     162     166
  1|     181
  0|
UNK|     115
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Total=  18




Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group              SPARKS v1.11
Data current thru: 31 Dec 1990 INTERNATIONAL                                 20 Apr 1992
```

```
                              Age Pyramid Report                            Report Date:
                          INDIAN RHINOCEROS Studbook                         20 Apr 1992
==============================  ==================================  ==========
Taxon Name: RHINOCEROS UNICORNIS                                        Page    3
====================  ====================  ==================  ==========
Age  Studbook Numbers >>>  Female
---  ----------------
 27|      31
 26|      34
 25|      38
 24|      40
 23|
 22|
 21|      51
 20|      55      56
 19|
 18|
 17|
 16|
 15|
 14|
 13|      97
 12|      93
 11|
 10|     110
  9|     113
  8|
  7|
  6|
  5|
  4|     144
  3|     148
  2|
  1|     183
  0|
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Total=  14




Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group
Data current thru: 31 Dec 1990 INTERNATIONAL                          SPARKS v1.11
                                                                      20 Apr 1992
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                              Fecundity & Mortality Report
Restricted to:                  INDIAN RHINOCEROS Studbook
 Locations: EUROPE    /
==========================================================================
Taxon Name: RHINOCEROS UNICORINIS
--------------------------------------------------------------------------

                  Fecundity [Mx]...                   Mortality [Qx]...
 Age Class     Male    N      Female    N          Male    N      Female    N
 ---------     ----   ---     ------   ---         ----   ---     ------   ---
   0- 1        0.00  29.4       0.00  17.8         0.11  36.0       0.16  24.3
   1- 2        0.00  27.7       0.00  17.6         0.04  26.6       0.06  15.9
   2- 3        0.00  24.7       0.00  16.5         0.00  23.3       0.00  16.5
   3- 4        0.00  22.2       0.00  16.5         0.00  22.2       0.00  16.5
   4- 5        0.00  20.0       0.07  14.5         0.00  20.0       0.00  14.5
   5- 6        0.00  19.5       0.04  13.7         0.00  19.5       0.00  13.7
   6- 7        0.00  18.0       0.11  14.0         0.00  18.0       0.00  14.0
   7- 8        0.00  17.5       0.10  14.8         0.00  17.0       0.00  14.8
   8- 9        0.12  16.7       0.13  15.0         0.00  16.7       0.00  15.0
   9-10        0.16  15.7       0.14  14.7         0.00  15.7       0.00  14.7
  10-11        0.17  15.0       0.15  13.3         0.00  15.0       0.00  13.3
  11-12        0.10  14.5       0.15  13.0         0.07  14.0       0.00  13.0
  12-13        0.04  13.2       0.13  11.9         0.08  12.3       0.00  11.6
  13-14        0.17  12.0       0.00  10.3         0.00  12.0       0.00  10.3
  14-15        0.18  11.3       0.05   9.4         0.09  10.6       0.11   9.0
  15-16        0.21   9.4       0.22   9.0         0.11   9.0       0.00   9.0
  16-17        0.28   9.0       0.06   9.0         0.11   9.0       0.00   9.0
  17-18        0.33   9.0       0.22   9.0         0.00   9.0       0.00   9.0
  18-19        0.13   7.7       0.11   9.0         0.29   7.0       0.00   9.0
  19-20        0.14   7.0       0.11   9.0         0.00   7.0       0.00   9.0
  20-21        0.17   6.0       0.06   8.4         0.00   6.0       0.00   8.4
  21-22        0.17   6.0       0.08   6.2         0.00   6.0       0.00   6.2
  22-23        0.00   6.0       0.17   6.0         0.00   6.0       0.00   6.0
  23-24        0.08   6.0       0.08   6.0         0.00   6.0       0.00   6.0
  24-25        0.00   4.3       0.08   6.0         0.00   4.3       0.00   6.0
  25-26        0.00   2.2       0.00   4.0         0.50   2.0       0.00   4.0
  26-27        0.25   2.0       0.14   3.7         0.00   2.0       0.00   3.4
  27-28        0.00   1.7       0.00   2.9         0.00   1.7       0.00   2.9
  28-29        0.00   1.0       0.25   2.0         0.00   1.0       0.00   2.0
  29-30        0.00   1.0       0.00   2.0         0.00   1.0       0.00   2.0
  30-31        0.00   1.0       0.00   2.0         0.00   1.0       0.00   2.0
  31-32        0.00   1.0       0.25   2.0         0.00   1.0       0.00   2.0
  32-33        0.00   1.0       0.00   2.0         0.00   1.0       0.00   2.0
  33-34        0.00   1.0       0.00   2.0         0.00   1.0       0.00   2.0
  34-35        0.00   1.0       0.00   2.0         0.00   1.0       0.00   2.0
  35-36        0.00   1.0       0.00   1.2         0.00   1.0       1.00   1.0
  36-37        0.00   1.0       0.00   0.8         0.00   1.0       0.00   0.0
  37-38        0.00   1.0       0.00   0.0         0.00   1.0       0.00   0.0
  38-39        0.00   1.0       0.00   0.0         0.00   1.0       0.00   0.0
  39-40        0.00   0.1       0.00   0.0         0.00   0.0       0.00   0.0
  40-41        0.00   0.0       0.00   0.0         0.00   0.0       0.00   0.0
  41-42        0.00   0.0       0.00   0.0         0.00   0.0       0.00   0.0

             T  = 14.507     T  = 17.014      30 day mortality: 12%
             Ro =  1.488     Ro =  2.127         (6 out of 51)
             lambda=1.03     lambda=1.05
             r  =  0.027     r  =  0.044

        51 birth events to known age parents tabulated for Mx...
```

```
        22 death events of known age tabulated for Qx...

   WARNING: Values with small sample sizes (N) warrant less confidence...

  Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group            SPARKS v1.11
  Data current thru: 31 Dec 1990 INTERNATIONAL                               20 Apr 1992
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```
                           Fecundity & Mortality Report
Restricted to:              INDIAN RHINOCEROS Studbook
 Locations: EUROPE    /
 Dates: During 01/01/1981 <= date
================================================================================
Taxon Name: RHINOCEROS UNICORINIS
--------------------------------------------------------------------------------

                  Fecundity [Mx]...                  Mortality [Qx]...
 Age Class     Male    N     Female    N          Male    N     Female    N
 ---------     ----   ---    ------   ---         ----   ---    ------   ---
   0- 1        0.00  13.0     0.00    5.7         0.07  14.0     0.23    8.6
   1- 2        0.00  12.9     0.00    6.7         0.08  12.9     0.18    5.7
   2- 3        0.00  10.1     0.00    5.0         0.00  10.1     0.00    5.0
   3- 4        0.00  10.1     0.00    4.6         0.00  10.1     0.00    4.6
   4- 5        0.00   7.8     0.00    3.4         0.00   7.8     0.00    3.4
   5- 6        0.00   7.5     0.00    3.0         0.00   7.5     0.00    3.0
   6- 7        0.00   6.0     0.33    3.0         0.00   6.0     0.00    3.0
   7- 8        0.00   6.0     0.00    3.8         0.00   6.0     0.00    3.8
   8- 9        0.30   5.0     0.25    4.0         0.00   5.0     0.00    4.0
   9-10        0.10   5.0     0.00    5.0         0.00   5.0     0.00    5.0
  10-11        0.29   5.2     0.29    5.3         0.00   5.2     0.00    5.3
  11-12        0.00   5.5     0.00    5.0         0.20   5.0     0.00    5.0
  12-13        0.11   4.4     0.11    4.6         0.00   4.4     0.00    4.6
  13-14        0.08   6.5     0.00    3.9         0.00   6.5     0.00    3.9
  14-15        0.08   6.6     0.00    5.0         0.00   6.6     0.00    5.0
  15-16        0.09   5.4     0.18    5.7         0.20   5.0     0.00    5.7
  16-17        0.18   5.6     0.08    6.4         0.00   5.6     0.00    6.4
  17-18        0.25   6.0     0.21    7.0         0.00   6.0     0.00    7.0
  18-19        0.00   5.6     0.14    7.0         0.20   5.0     0.00    7.0
  19-20        0.10   5.0     0.14    7.0         0.00   5.0     0.00    7.0
  20-21        0.12   4.1     0.00    6.4         0.00   4.1     0.00    6.4
  21-22        0.13   4.0     0.12    4.2         0.00   4.0     0.00    4.2
  22-23        0.00   4.1     0.13    4.0         0.00   4.1     0.00    4.0
  23-24        0.10   5.0     0.13    4.0         0.00   5.0     0.00    4.0
  24-25        0.00   3.3     0.00    4.0         0.00   3.3     0.00    4.0
  25-26        0.00   1.2     0.00    2.0         1.00   1.0     0.00    2.0
  26-27        0.50   1.0     0.00    1.7         0.00   1.0     0.00    1.7
  27-28        0.00   0.7     0.00    0.9         0.00   0.7     0.00    0.9
  28-29        0.00   0.0     0.00    0.0         0.00   0.0     0.00    0.0
  29-30        0.00   0.0     0.00    0.0         0.00   0.0     0.00    0.0

            T   = 13.061    T   = 13.887    30 day mortality: 14%
            Ro =   1.257    Ro =   1.332      (3 out of 21)
            lambda=1.02     lambda=1.02
            r   =   0.018   r   =   0.021

        21 birth events to known age parents tabulated for Mx...

        12 death events of known age tabulated for Qx...

 WARNING: Values with small sample sizes (N) warrant less confidence...


Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group        SPARKS V1.11
Data current thru: 31 Dec 1990 INTERNATIONAL                           21 Apr 1992
```

```
                              Fecundity & Mortality Report
Restricted to:                 INDIAN RHINOCEROS Studbook
 Locations: EUROPE   /
 Dates: During 01/01/1982 <= date
=================================================================================
Taxon Name: RHINOCEROS UNICORINIS
=================================================================================

                     Fecundity [Mx]...                  Mortality [Qx]...
 Age Class       Male    N     Female    N         Male    N     Female    N
 ---------       ----   ---    ------   ---        ----   ---    ------   ---
   0- 1          0.00  12.7     0.00    5.7        0.07  13.7     0.15    6.6
   1- 2          0.00  11.9     0.00    5.5        0.08  11.9     0.22    4.5
   2- 3          0.00  10.0     0.00    4.7        0.00  10.0     0.00    4.7
   3- 4          0.00   8.4     0.00    4.5        0.00   8.4     0.00    4.5
   4- 5          0.00   7.2     0.00    3.4        0.00   7.2     0.00    3.4
   5- 6          0.00   5.9     0.00    3.0        0.00   5.9     0.00    3.0
   6- 7          0.00   6.0     0.33    3.0        0.00   6.0     0.00    3.0
   7- 8          0.00   5.1     0.00    3.8        0.00   5.1     0.00    3.8
   8- 9          0.32   4.7     0.25    4.0        0.00   4.7     0.00    4.0
   9-10          0.00   4.3     0.00    3.7        0.00   4.3     0.00    3.7
  10-11          0.30   5.0     0.28    3.6        0.00   5.0     0.00    3.6
  11-12          0.00   4.6     0.00    5.0        0.24   4.2     0.00    5.0
  12-13          0.12   4.3     0.11    4.6        0.00   4.3     0.00    4.6
  13-14          0.00   4.1     0.00    3.3        0.00   4.1     0.00    3.3
  14-15          0.08   6.1     0.00    3.6        0.00   6.1     0.00    3.6
  15-16          0.09   5.4     0.20    5.0        0.20   5.0     0.00    5.0
  16-17          0.20   5.0     0.00    5.7        0.00   5.0     0.00    5.7
  17-18          0.27   5.6     0.23    6.5        0.00   5.6     0.00    6.5
  18-19          0.00   5.6     0.14    7.0        0.20   5.0     0.00    7.0
  19-20          0.10   5.0     0.14    7.0        0.00   5.0     0.00    7.0
  20-21          0.12   4.0     0.00    6.4        0.00   4.0     0.00    6.4
  21-22          0.13   4.0     0.12    4.2        0.00   4.0     0.00    4.2
  22-23          0.00   4.0     0.13    4.0        0.00   4.0     0.00    4.0
  23-24          0.12   4.1     0.13    4.0        0.00   4.1     0.00    4.0
  24-25          0.00   3.3     0.00    4.0        0.00   3.3     0.00    4.0
  25-26          0.00   1.2     0.00    2.0        1.00   1.0     0.00    2.0
  26-27          0.50   1.0     0.00    1.7        0.00   1.0     0.00    1.7
  27-28          0.00   0.7     0.00    0.9        0.00   0.7     0.00    0.9
  28-29          0.00   0.0     0.00    0.0        0.00   0.0     0.00    0.0
  29-30          0.00   0.0     0.00    0.0        0.00   0.0     0.00    0.0

               T  - 13.291   T  = 13.864      30 day mortality: 11%
               Ro -  1.146   Ro =  1.366        (2 out of 19)
               lambda-1.01   lambda=1.02
               r  =  0.010   r  =  0.022

          19 birth events to known age parents tabulated for Mx...

          11 death events of known age tabulated for Qx...

 WARNING: Values with small sample sizes (N) warrant less confidence...


 Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group           SPARKS V1.11
 Data current thru: 31 Dec 1990 INTERNATIONAL                              20 Apr 1992
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FOUNDER ANALYSIS - *RHINOCEROS UNICORINIS* - EUROPE - 20/04/1992

Founder representation in each living animal:
  Founders listed across top, descendants down side.
  Founder calculations omit UNKNOWNs.
  Studbook numbers beginning with P indicate wild or unknown founders that
    mated with studbook # without the P to produce CB offspring.

```
Founders:
                      21         1         7         5        11        16        19
                     P21        33        43        40        94        73       144

Founder contributions:
                  0.2500    0.7500    6.2500    6.2500    0.7500    1.0000    9.5000
                  0.2500    1.5000    1.5000    0.5000    0.5000    1.0000    0.0000

Fractional contributions:
                  0.0083    0.0250    0.2083    0.2083    0.0250    0.0333    0.3167
                  0.0083    0.0500    0.0500    0.0167    0.0167    0.0333    0.0000

Number of living descendants:
                       1         2        24        16         2         2        23
                       1         5         5         1         1         2         0
```

GENE DROP - *RHINOCEROS UNICORINIS* - EUROPE - 20/04/1992

Studbook	Sire	Dam	Status (cap=alive)	Prop. genome living desc.	unique among all living
21 F	WILD	WILD	f		
1 M	WILD	WILD	f		
7 F	WILD	WILD	f		
5 M	WILD	WILD	f		
11 F	WILD	WILD	f		
16 F	WILD	WILD	f		
18 M	WILD	WILD	f		
17 F	5	7	d		
P21 M	WILD	WILD	f		
23 F	P21	21	d		
33 M	WILD	WILD	f		
43 F	WILD	WILD	f		
31 F	5	7	A	0.0720	0.0720
32 M	5	16	A	0.3075	0.3075
34 F	5	17	A	0.0050	0.0050
38 F	18	16	A	0.2445	0.2445
40 F	WILD	WILD	F		0.5000
39 M	18	7	A	0.0835	0.0835
41 M	18	17	A	0.0010	0.0010
42 M	1	11	A	0.5000	0.5000
94 M	WILD	WILD	f		
73 M	WILD	WILD	f		
51 F	33	43	A	0.0600	0.0600
55 F	18	17	A	0.0045	0.0045
56 F	18	7	A	0.0035	0.0035
60 M	18	31	A	0.0000	0.0000
86 M	41	34	A	0.0000	0.0000
97 F	94	23	A	1.0000	1.0000
93 F	41	34	A	0.0000	0.0000
100 M	18	56	A	0.0005	0.0005
110 F	18	56	A	0.0030	0.0030
113 F	73	55	A	0.2520	0.2520
123 M	41	34	A	0.0000	0.0000
132 M	60	51	A	0.0000	0.0000
134 M	73	55	A	0.2520	0.2520
135 M	41	34	A	0.0000	0.0000
141 M	86	93	A	0.0000	0.0000
144 F	WILD	WILD	F		1.0000
145 M	60	51	A	0.0000	0.0000
148 F	100	56	A	0.0000	0.0000
152 M	41	34	A	0.0000	0.0000
162 M	60	51	A	0.0000	0.0000
166 M	42	40	A	0.5000	0.0000
181 M	100	110	A	0.0000	0.0000
183 F	100	56	A	0.0000	0.0000
115 M	60	51	A	0.0000	0.0000

14 Founders 30 Living descendants 45 In total pedigree

FOUNDER ALLELE REPRESENTATION

Founder		Retention	%Representation	Target	Difference
21	F	0.243	0.810	2.598	1.788
1	M	0.500	2.510	5.345	2.835
7	F	0.340	21.030	10.048	-10.982
5	M	0.927	20.707	9.909	-10.798
11	F	0.500	2.490	5.345	2.855
16	F	0.741	3.333	7.916	4.582
18	M	0.996	31.595	10.647	-20.948
P21	M	0.257	0.857	2.747	1.891
33	M	0.500	5.035	5.345	0.310
43	F	0.500	4.963	5.339	0.376
40	FL	0.500	1.667	10.689	9.023
94	M	0.500	1.667	5.345	3.678
73	M	0.752	3.333	8.038	4.705
144	FL	0.000	0.000	10.689	10.689

GENETIC SUMMARY	LIVING DESCENDANT POPULATION	POTENTIAL
Number of founders:	13	14
Mean retention:	0.604	0.668
Founder genomes surviving:	7.855	9.355
Founder Equivalents:	5.100	12.116
Founder Genome Equivalents:	3.690	9.355
Fraction of wild gene diversity retained:	0.865	0.947
Fraction of wild gene diversity lost:	0.135	0.053
Mean inbreeding coefficient:	0.107	

RHINOCEROS UNICORINIS - EUROPE - 20/04/1992

ORDERED LISTS OF MEAN KINSHIP BY SEX:

Rank	MALES	MK	Known	FEMALES	MK	Known
1	42	0.0250	1.0000	144	0.0000	1.0000
2	166	0.0250	1.0000	40	0.0023	1.0000
3	32	0.0669	1.0000	97	0.0167	1.0000
4	134	0.1011	1.0000	51	0.0500	1.0000
5	132	0.1167	1.0000	38	0.0958	1.0000
6	145	0.1167	1.0000	113	0.1011	1.0000
7	162	0.1167	1.0000	31	0.1250	1.0000
8	113	0.1167	1.0000	34	0.1583	1.0000
9	39	0.1396	1.0000	56	0.1646	1.0000
10	60	0.1667	1.0000	55	0.1666	1.0000
11	123	0.1792	1.0000	110	0.1749	1.0000
12	135	0.1792	1.0000	183	0.1807	1.0000
13	152	0.1792	1.0000	148	0.1807	1.0000
14	100	0.1823	1.0000	93	0.1826	1.0000
15	86	0.1828	1.0000			
16	161	0.1844	1.0000			
17	41	0.1854	1.0000			
18	141	0.1896	1.0000			

GENETIC SUMMARY OF POPULATION

Descendant population mean kinship:	0.1351
Gene diversity:	0.8649
Founder Genome Equivalents:	3.7007

INDIAN RHINOCEROS Studbook

(Rhinoceros unicornis)

Restricted to:
Locations: N.AMERICA/
Dates: During 19/04/1992 <= date .and. date <- 20/04/1992
Status: Living during 19 Apr 1992 -> 20 Apr 1992

Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
10	M	1 Jan 1955	WILD	WILD	ASSAM P	14 Sep 1955	UNK	Wild Born	INDIA		KAMAKBALA	PHILA 1
					PHILADELP	14 Sep 1955	UNK		U.S.A.			
26	M	31 Aug 1962	5	7	BASEL	31 Aug 1962	UNK	Captive Born	SWITZRLND		LASAI	
					SD-WAP	26 Apr 1972	UNK		U.S.A.			
29	F	10 Jul 1963	24	82	ASSAM	10 Jul 1963	UNK	Captive Born	INDIA		JAYPURI	
					SD WAP	26 Apr 1972	UNK		U.S.A.			
35	M	- 1966	WILD	WILD	ASSAM P	8 Mar 1966	UNK	Wild Born	INDIA		HERMAN	LA 1
					LOSANGELE	8 Mar 1966	UNK		U.S.A.			
45	F	5 Oct 1969	18	17	BASEL	5 Oct 1969	UNK	Captive Born	SWITZRLND		RANDA	BASEL 10
					LOSANGELE	22 Nov 1974	UNK		U.S.A.			
49	M	1 Jun 1969	WILD	WILD	NEPAL	23 Apr 1970	UNK	Wild Born	NEPAL		MOHAN	MIAMI 1
					METROZOO	23 Apr 1970	UNK		U.S.A.			
50	F	????	WILD	WILD	NEPAL	12 Jun 1970	UNK	Wild Born	NEPAL		SHANTI	MIAMI 2
					METROZOO	12 Jun 1970	UNK		U.S.A.			
					PHILADELP	10 Apr 1987	UNK		U.S.A.			
					NY BRONX	22 Nov 1988	UNK		U.S.A.			
					METROZOO	29 Mar 1990	UNK		U.S.A.			
55	M	16 Apr 1971	1	11	MYSORE	16 Apr 1971	UNK	Captive Born	INDIA		VINU	
					TORONTO	12 Jun 1976	UNK		CANADA			
					NY BRONX	30 May 1990	UNK		U.S.A.			
66	F	- 1974	WILD	WILD	ASSAM P	- 1974	UNK	Wild Born	INDIA		MAYANG KUM	
					ASSAM	- 1974	UNK		INDIA			
					NY BRONX	30 Jan 1975	UNK		U.S.A.			
67	F	- 1974	WILD	WILD	ASSAM P	- 1974	UNK	Wild Born	INDIA			
					ASSAM	- 1974	UNK		INDIA			
					NY BRONX	30 Jan 1975	UNK		U.S.A.			
69	M	30 Jan 1974	19	29	NZP-WASH	30 Jan 1974	UNK	Captive Born	U.S.A.		PATRICK	WASH 3
					TORONTO	16 Jun 1985	UNK		CANADA			
79	F	19 Jul 1975	1	11	MYSORE	19 Jul 1975	UNK	Captive Born	INDIA		INDIRA	
					TORONTO	27 Apr 1979	UNK		CANADA			
80	F	10 Oct 1975	18	7	BASEL	10 Oct 1975	UNK	Captive Born	SWITZRLND		XAVIRA	
					PHILADELP	6 Nov 1979	UNK		U.S.A.			
83	M	18 Feb 1976	18	31	BERLIN W	18 Feb 1976	UNK	Captive Born	W.GERMANY		HEINER	
					(NY BRONX)	25 Dec 1983	UNK		U.S.A.			

Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group
Data current thru: 31 Dec 1990 INTERNATIONAL

SPARKS v1.11
24 Apr 1992

INDIAN RHINOCEROS Studbook
(Rhinoceros unicorinis)

Restricted to:
Locations: N.AMERICA/
Dates: During 19/04/1992 <= date .and. date <- 20/04/1992
Status: Living during 19 Apr 1992 -> 20 Apr 1992

Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
87	M	26 Jan 1978	16	56	BASEL	26 Jan 1978	UNK	Captive Born	SWITZRLND		ASSAM	
					NY BRONX	- 1982	UNK		U.S.A.			
					MILWAUKEE	31 Oct 1991	UNK		U.S.A.			
89	F	13 Aug 1979	32	31	BERLIN W	13 Aug 1979	UNK	Captive Born	W.GERMANY		TERAI	
					OKLAHOMA	10 Jul 1981	UNK		U.S.A.			
					LOSANGELE	13 Nov 1990	UNK		U.S.A.			
99	F	19 Mar 1978	26	29	SD-WAP	19 Mar 1978	UNK	Captive Born	U.S.A.		GAINDA	SDWAP 3
						19 Mar 1978	UNK					
101	M	8 Aug 1980	26	29	SD-WAP	8 Aug 1980	UNK	Captive Born	U.S.A.		PANDU	SDWAP 4
					NZP-WASH	25 Jun 1985	UNK		U.S.A.			
106	M	15 May 1981	76	77	HYDERABAD	15 May 1981	UNK	Captive Born	INDIA		RABHA	
					SD-WAP	29 Jun 1985	UNK		U.S.A.			
116	M	1 May 1983	26	29	SD-WAP	1 May 1983	UNK	Captive Born	U.S.A.		JORHAT	SDWAP 6
					SANDIEGOZ	23 Jun 1986	UNK		U.S.A.			
					LOWRY	23 Jun 1986	UNK		U.S.A.			
125	M	11 Aug 1985	35	46	LOSANGELE	11 Aug 1985	UNK	Captive Born	U.S.A.		CHANDRA	LA 4
					OKLAHOMA	14 Nov 1990	UNK		U.S.A.			
126	M	3 Nov 1985	10	80	PHILADELP	3 Nov 1985	UNK	Captive Born	U.S.A.		AKBAR	PHILA 2
					METROZOO	1 Jan 1989	UNK		U.S.A.			
130	F	18 Jan 1985	26	99	SD-WAP	18 Jan 1985	UNK	Captive Born	U.S.A.		JUNTA	SDWAP 8
131	F	9 Apr 1986	63	66	NY BRONX	9 Apr 1986	UNK	Captive Born	U.S.A.			
136	M	- Apr 1986	WILD	WILD	NEPAL	- Apr 1986	UNK	Wild Born	NEPAL		CHHENDRA	
					SAN FRAN	26 May 1987	UNK		U.S.A.			
137	F	- Oct 1986	WILD	WILD	NEPAL	- Oct 1986	UNK	Wild Born	NEPAL		SHANTI	
					SAN FRAN	26 May 1987	UNK		U.S.A.			
138	F	- Mar 1986	WILD	WILD	NEPAL	- Mar 1986	UNK	Wild Born	NEPAL		MECHI	
					NZP-WASH	27 May 1987	UNK		U.S.A.			
139	F	- Nov 1986	WILD	WILD	NEPAL	- Nov 1986	UNK	Wild Born	NEPAL		KALI	
					NZP-WASH	27 May 1987	UNK		U.S.A.			
143	F	26 May 1987	26	99	SD-WAP	26 May 1987	UNK	Captive Born	U.S.A.		GOALPARA	SDWAP 9
146	M	22 May 1988	26	29	SD-WAP	22 May 1988	UNK	Captive Born	U.S.A.		JOYA	SDWAP 10
					SANDIEGOZ	22 May 1988	UNK		U.S.A.			

Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group
Data current thru: 31 Dec 1990 INTERNATIONAL

SPARKS v1.11
24 Apr 1992

INDIAN RHINOCEROS studbook
(Rhinoceros unicornis)

Restricted to:
Locations: N.AMERICA/
Dates: During 19/04/1992 <= date .and. date <= 20/04/1992
Status: Living during 19 Apr 1992 -> 20 Apr 1992

Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth Origin	Country	Death-Date	Name	Breeder #
147	M	14 Aug 1988	10	80	PHILADELP	14 Aug 1988	UNK	Captive Born	U.S.A.		JIMMY	PHILA 3
					CINCINNAT	24 Oct 1989	UNK		U.S.A.			
161	F	9 May 1989	83	66	NY BRONX >	9 May 1989	UNK	Captive Born	U.S.A.			OKLA 1
					OKLAHOMA	9 May 1989	UNK		U.S.A.			
160	M	27 Jan 1990	26	29	SD-WAP	27 Jan 1990	UNK	Captive Born	U.S.A.		JAUNPUR	SDWAP 12
						27 Jan 1990	UNK					
182	F	20 Jul 1990	106	130	SD-WAP	20 Jul 1990	UNK	Captive Born	U.S.A.		JHANSI	SDWAP 13
184	M	28 Dec 1990	106	99	SD-WAP	28 Dec 1990	UNK	Captive Born	U.S.A.		GUJRAT	SDWAP 14
T9009	M	24 Jul 1991	10	80	PHILADELP	24 Jul 1991	UNK	Captive Born	U.S.A.		DHALAGURI	PHILA 4
						24 Jul 1991	UNK					
T9010	M	6 Jun 1989	WILD	WILD	FORTWORTH	10 May 1990	UNK	Wild Born	U.S.A.		ARUN	
						10 May 1990	UNK					
T9011	F	6 Jun 1989	WILD	WILD	FORTWORTH	10 May 1990	UNK	Wild Born	U.S.A.		ARATI	
						10 May 1990	UNK					
T9012	F	25 Dec 1991	69	79	TORONTO	25 Dec 1991	UNK	Captive Born	CANADA			TOR 1
						25 Dec 1991	UNK					
T9013	M	22 Dec 1991	106	145	SD-WAP	22 Dec 1991	UNK	Captive Born	U.S.A.		GANGTOK	SDWAP 14
						22 Dec 1991	UNK					

TOTALS: 21.19.0 (40)

Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group
Data current thru: 31 Dec 1990 INTERNATIONAL

SPARKS v1.11
24 Apr 1992

```
                                         Age Pyramid Report
Restricted to:                     INDIAN RHINOCEROS Studbook
 Locations: N.AMERICA/
 Dates: As of End of 19/04/1992 <= date
 ============================================     =================== = ===========
Taxon Name: RHINOCEROS UNICORINIS
====================================================================================================
Age                                             Males|Females
---                    N =  21               ----------------                 N -  18
 37-                                                X|
 36-                                                 |
 35-                                                 |
 34-                                                 |
 33-                                                 |
 32-                                                 |
 31-                                                 |
 30-                                                 |
 29-                                                X|
 28-                                                 |X
 27-                                                 |
 26-                                                X|
 25-                                                 |
 24-                                                 |
 23-                                                 |
 22-                                                X|X
 21-                                                X|
 20-                                                 |
 19-                                                 |
 18-                                                X|XX
 17-                                                 |
 16-                                                X|XX
 15-                                                 |
 14-                                                X|X
 13-                                                 |
 12-                                                 |X
 11-                                                X|
 10-                                                X|
  9-                                                 |
  8-                                                X|
  7-                                                 |X
  6-                                              XXX|XX
  5-                                                 |XX
  4-                                                 |X
  3-                                               XX|
  2-                                               XX|XX
  1-                                                X|X
  0-                                               XX|X
- - - - - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - - -
         32   28   24   20   16   12    8    4         4    8   12   16   20   24   28   32
                                          Number of Animals

 X >>> Specimens of known sex...
 ? >>> Specimens of unknown sex...
     1 Female Specimens of unknown age...


Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group                    SPARKS v1.11
Data current thru: 31 Dec 1990 INTERNATIONAL                                       20 Apr 1992
```

```
                                  Age Pyramid Report                      Report Date:
                              INDIAN RHINOCEROS Studbook                   20 Apr 1992
==============================================================================
Taxon Name: RHINOCEROS UNICORINIS                                     Page    2
==============================================================================
Age  Studbook Numbers >>>  Male
---  ----------------
 37|     10
 36|
 35|
 34|
 33|
 32|
 31|
 30|
 29|     26
 28|
 27|
 26|     35
 25|
 24|
 23|
 22|     49
 21|     53
 20|
 19|
 18|     69
 17|
 16|     83
 15|
 14|     87
 13|
 12|
 11|    101
 10|    106
  9|
  8|    116
  7|
  6|    125    126    136
  5|
  4|
  3|    146    147
  2|    180  T9010
  1|    184
  0|  T9009  T9013
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Total=  21



Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group       SPARKS v1.11
Data current thru: 31 Dec 1990 INTERNATIONAL                          20 Apr 1992
```

```
                              Age Pyramid Report                   Report Date:
                         INDIAN RHINOCEROS Studbook                 20 Apr 1992
==================== ==========================================  ================
Taxon Name: RHINOCEROS UNICORINIS                                   Page      3
=================== ====================================   ====================
Age  Studbook Numbers >>>  Female
---  ----------------
 37|
 36|
 35|
 34|
 33|
 32|
 31|
 30|
 29|
 28|      29
 27|
 26|
 25|
 24|
 23|
 22|      45
 21|
 20|
 19|
 18|      66      67
 17|
 16|      79      80
 15|
 14|      99
 13|
 12|      89
 11|
 10|
  9|
  8|
  7|     130
  6|     131     138
  5|     137     139
  4|     143
  3|
  2|     161   T9011
  1|     182
  0|   T9012
UNK|      50
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Total=  19




Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group      SPARKS v1.11
Data current thru: 31 Dec 1990 INTERNATIONAL                          20 Apr 1992
```

```
                        Fecundity & Mortality Report
Restricted to:           INDIAN RHINOCEROS Studbook
 Locations: N.AMERICA/
==========================================================================
Taxon Name: RHINOCEROS UNICORINIS
==========================================================================

                  Fecundity [Mx]...                Mortality [Qx]...
 Age Class     Male    N      Female    N        Male    N      Female    N
 ---------     ----   ---     ------   ---       ----   ---     ------   ---
   0- 1        0.00   13.5     0.00     8.7      0.21   19.5     0.32   15.7
   1- 2        0.00   15.6     0.00    15.0      0.12   16.8     0.06   15.9
   2- 3        0.00   14.3     0.00    16.2      0.00   14.3     0.00   16.2
   3- 4        0.00   14.6     0.00    14.4      0.00   14.6     0.14   14.2
   4- 5        0.00   14.9     0.07    14.8      0.00   14.9     0.00   14.8
   5- 6        0.00   15.8     0.04    13.9      0.00   15.8     0.00   13.9
   6- 7        0.00   14.2     0.04    11.2      0.00   14.2     0.00   11.2
   7- 8        0.04   13.2     0.05    10.3      0.00   13.2     0.00   10.3
   8- 9        0.00   14.0     0.05    10.2      0.00   14.0     0.00   10.2
   9-10        0.07   13.4     0.09    11.0      0.00   13.4     0.00   11.0
  10-11        0.11   13.9     0.09    11.0      0.00   13.9     0.00   11.0
  11-12        0.00   12.7     0.09    11.0      0.00   12.7     0.00   11.0
  12-13        0.04   11.7     0.18    11.4      0.09   11.0     0.00   11.4
  13-14        0.05   11.0     0.09    11.0      0.00   11.0     0.00   11.0
  14-15        0.05   10.2     0.10    10.1      0.00   10.2     0.11    9.1
  15-16        0.10   10.0     0.11     9.0      0.00   10.0     0.10   10.0
  16-17        0.11    9.2     0.12     8.3      0.00    9.2     0.00    8.3
  17-18        0.17    9.0     0.16     6.1      0.00    9.0     0.40    5.0
  18-19        0.00    8.2     0.00     3.4      0.00    8.2     0.00    3.4
  19-20        0.13    8.0     0.17     2.9      0.00    8.0     0.50    2.0
  20-21        0.13    8.0     0.00     2.0      0.00    8.0     0.00    2.0
  21-22        0.00    7.0     0.00     2.0      0.00    7.0     0.00    2.0
  22-23        0.35    6.9     0.00     1.5      0.00    6.9     0.00    1.5
  23-24        0.00    6.0     0.50     1.0      0.00    6.0     0.00    1.0
  24-25        0.17    6.0     0.50     1.0      0.00    5.0     0.00    1.0
  25-26        0.08    6.0     0.00     1.0      0.00    6.0     0.00    1.0
  26-27        0.00    5.2     0.50     1.0      0.00    5.2     0.00    1.0
  27-28        0.10    5.0     0.00     1.0      0.00    5.0     0.00    1.0
  28-29        0.00    5.0     0.00     0.8      0.00    5.0     0.00    0.8
  29-30        0.11    4.6     0.00     0.0      0.00    4.6     0.00    0.0
  30-31        0.16    3.0     0.00     0.0      1.00    1.0     0.00    0.0
  31-32        0.00    1.0     0.00     0.0      0.00    1.0     0.00    0.0
  32-33        0.00    1.0     0.00     0.0      0.00    1.0     0.00    0.0
  33-34        0.50    1.0     0.00     0.0      0.00    1.0     0.00    0.0
  34-35        0.00    1.0     0.00     0.0      0.00    1.0     0.00    0.0
  35-36        0.00    1.0     0.00     0.0      0.00    1.0     0.00    0.0
  36-37        0.50    1.0     0.00     0.0      0.00    1.0     0.00    0.0
  37-38        0.00    0.3     0.00     0.0      0.00    0.3     0.00    0.0
  38-39        0.00    0.0     0.00     0.0      0.00    0.0     0.00    0.0
  39-40        0.00    0.0     0.00     0.0      0.00    0.0     0.00    0.0

             T  = 18.710      T  = 14.571     30 day mortality: 30%
             Ro =   1.033     Ro =   0.847       (9 out of 30)
             lambda=1.00      lambda=0.99
             r  =   0.002     r  = -0.011

        30 birth events to known age parents tabulated for Mx...

        23 death events of known age tabulated for Qx...
```

```
                           Fecundity & Mortality Report
Restricted to:              INDIAN RHINOCEROS Studbook
 Locations: N.AMERICA/
 Dates: During 01/01/1981 <- date
==============================================================================
Taxon Name: RHINOCEROS UNICORINIS
==============================================================================

                  Fecundity (Mx)...               Mortality (Qx)...
 Age Class      Male   N     Female   N        Male    N     Female    N
 ---------      ----  ---    ------  ---       ----   ---    ------   ---
   0- 1         0.00  10.8    0.00   7.2       0.16  12.8     0.33   12.2
   1- 2         0.00  10.4    0.00   9.6       0.00  10.2     0.00    9.6
   2- 3         0.00   9.1    0.00  10.0       0.00   9.1     0.00   10.0
   3- 4         0.00   7.6    0.00   8.4       0.00   7.6     0.11    9.0
   4- 5         0.00   7.2    0.13   7.9       0.00   7.2     0.00    7.9
   5- 6         0.00   7.0    0.07   7.3       0.00   7.0     0.00    7.3
   6- 7         0.00   5.3    0.09   5.3       0.00   5.3     0.00    5.3
   7- 8         0.10   5.2    0.08   6.3       0.00   5.2     0.00    6.3
   8- 9         0.00   6.0    0.08   6.0       0.00   6.0     0.00    6.0
   9-10         0.19   5.3    0.08   6.0       0.00   5.3     0.00    6.0
  10-11         0.17   5.9    0.08   6.0       0.00   5.9     0.00    6.0
  11-12         0.00   5.1    0.07   6.8       0.00   5.1     0.00    6.8
  12-13         0.00   5.0    0.26   7.7       0.00   5.0     0.00    7.7
  13-14         0.10   5.0    0.07   7.0       0.00   5.0     0.00    7.0
  14-15         0.00   4.3    0.08   6.1       0.00   4.3     0.00    6.1
  15-16         0.00   5.0    0.17   6.0       0.00   5.0     0.00    6.0
  16-17         0.24   4.2    0.19   5.3       0.00   4.2     0.00    5.3
  17-18         0.25   4.0    0.11   4.5       0.00   4.0     0.00    4.5
  18-19         0.00   3.9    0.00   3.4       0.00   3.9     0.00    3.4
  19-20         0.25   4.0    0.17   2.9       0.00   4.0     0.50    2.0
  20-21         0.25   4.0    0.00   2.0       0.00   4.0     0.00    2.0
  21-22         0.00   3.0    0.00   2.0       0.00   3.0     0.00    2.0
  22-23         0.26   3.9    0.00   1.5       0.00   3.9     0.00    1.5
  23-24         0.00   3.0    0.50   1.0       0.00   3.0     0.00    1.0
  24-25         0.27   3.7    0.50   1.0       0.00   2.8     0.00    1.0
  25-26         0.13   4.0    0.00   1.0       0.00   4.0     0.00    1.0
  26-27         0.00   4.2    0.50   1.0       0.00   4.2     0.00    1.0
  27-28         0.13   4.0    0.00   1.0       0.00   4.0     0.00    1.0
  28-29         0.00   4.0    0.00   0.8       0.00   4.0     0.00    0.8
  29-30         0.14   3.6    0.00   0.0       0.00   3.6     0.00    0.0
  30-31         0.23   2.1    0.00   0.0       1.00   1.0     0.00    0.0
  31-32         0.00   1.0    0.00   0.0       0.00   1.0     0.00    0.0
  32-33         0.00   1.0    0.00   0.0       0.00   1.0     0.00    0.0
  33-34         0.50   1.0    0.00   0.0       0.00   1.0     0.00    0.0
  34-35         0.00   1.0    0.00   0.0       0.00   1.0     0.00    0.0
  35-36         0.00   1.0    0.00   0.0       0.00   1.0     0.00    0.0
  36-37         0.50   1.0    0.00   0.0       0.00   1.0     0.00    0.0
  37-38         0.00   0.3    0.00   0.0       0.00   0.3     0.00    0.0
  38-39         0.00   0.0    0.00   0.0       0.00   0.0     0.00    0.0
  39-40         0.00   0.0    0.00   0.0       0.00   0.0     0.00    0.0

               T   = 18.658    T   = 15.606    30 day mortality: 25%
               Ro  =  2.084    Ro  =  1.428       (6 out of 24)
               lambda=1.04     lambda=1.02
               r   =  0.039    r   =  0.023

        24 birth events to known age parents tabulated for Mx...

        10 death events of known age tabulated for Qx...
```

WARNING: Values with small sample sizes (N) warrant less confidence...

Compiled by: MICHAEL DEE thru Captive Breeding Specialist Group
Data current thru: 31 Dec 1990 INTERNATIONAL

SPARKS v1.11
21 Apr 1992

FOUNDER ANALYSIS - *RHINOCEROS UNICORINIS* - NORTH AMERICA - 20/04/1992

Founder representation in each living animal:
  Founders listed across top, descendants down side.
  Founder calculations omit UNKNOWNs.
  Studbook numbers beginning with P indicate wild or unknown founders that
    mated with studbook # without the P to produce CB offspring.

Founders:

```
     24        50        82         1         7         5        11
     30        10        16        18        19        76       P30
     77        35        46        49        66        67       138
    136       137       139     T9010     T9011
```

Founder contributions:

```
 2.2500    0.0000    2.2500    1.2500    5.5000    4.2500    1.2500
 0.3750    1.5000    0.2500    3.5000    0.7500    1.2500    0.3750
 1.2500    0.5000    0.5000    0.0000    1.0000    0.0000    0.0000
 0.0000    0.0000    0.0000    0.0000    0.0000
```

Fractional contributions:

```
 0.0804    0.0000    0.0804    0.0446    0.1964    0.1518    0.0446
 0.0134    0.0536    0.0089    0.1250    0.0268    0.0446    0.0134
 0.0446    0.0179    0.0179    0.0000    0.0357    0.0000    0.0000
 0.0000    0.0000    0.0000    0.0000    0.0000
```

Number of living descendants:

```
     11         0        11         3        21        16         3
      2         3         1         9         2         4         2
      4         1         1         0         2         0         0
      0         0         0         0         1
```

GENE DROP - *RHINOCEROS UNICORINIS* - NORTH AMERICA - 20/04/1992

Studbook	Sire	Dam	Status (cap=alive)	Prop. genome living desc.	unique among all living
24 M	WILD	WILD	f		
50 F	WILD	WILD	F		1.0000
62 F	WILD	WILD	f		
1 M	WILD	WILD	f		
7 F	WILD	WILD	f		
5 M	WILD	WILD	f		
11 F	WILD	WILD	f		
30 F	WILD	WILD	f		
10 M	WILD	WILD	F		0.1280
16 F	WILD	WILD	f		
18 M	WILD	WILD	f		
17 F	5	7	d		
19 M	WILD	WILD	f		
26 M	5	7	A	0.0030	0.0030
76 M	WILD	WILD	f		
P30 M	WILD	WILD	f		
28 F	P30	10	d		
29 F	24	62	A	0.0335	0.0335
77 F	WILD	WILD	f		
31 F	5	7	d		
32 M	5	16	d		
35 M	WILD	WILD	F		0.5000
46 F	WILD	WILD	f		
49 M	WILD	WILD	F		1.0000
45 F	18	17	A	0.1270	0.1270
53 M	1	11	A	0.4850	0.4850
56 F	18	7	d		
69 M	19	28	A	0.5000	0.5000
66 F	WILD	WILD	F		0.2550
67 F	WILD	WILD	F		1.0000
79 F	1	11	A	0.2360	0.2360
80 F	18	7	A	0.0215	0.0215
83 M	18	31	A	0.0160	0.0160
87 M	18	56	A	0.0900	0.0900
99 F	26	29	A	0.0000	0.0000
89 F	32	31	A	0.3505	0.3505
101 M	26	29	A	0.0000	0.0000
106 M	76	77	A	0.1290	0.1290
116 M	26	29	A	0.0000	0.0000
130 F	26	99	A	0.0000	0.0000
125 M	35	46	A	1.0000	0.5000
126 M	10	80	A	0.1235	0.0000
138 F	WILD	WILD	F		1.0000
136 M	WILD	WILD	F		1.0000
131 F	83	66	A	0.2450	0.0000
137 F	WILD	WILD	F		1.0000
139 F	WILD	WILD	F		1.0000
143 F	26	99	A	0.0000	0.0000
145 M	26	29	A	0.0000	0.0000
147 M	10	80	A	0.1255	0.0000
161 F	83	66	A	0.2450	0.0000
T9010 M	WILD	WILD	F		1.0000
T9011 F	WILD	WILD	F		1.0000
180 M	26	29	A	0.0000	0.0000
182 F	106	130	A	0.0000	0.0000
184 M	106	99	A	0.0000	0.0000
T9009 M	10	80	A	0.1230	0.0000

```
  Studbook     Sire       Dam   Status    Prop. genome unique among
                              (cap=alive) living desc.   all living

   T9013 M      106       143  A           0.0000        0.0000
   T9012 F       69        79  A           0.0000        0.0000

-------------------- --------------------------------------------------

    26 Founders      28 Living descendants      59 In total pedigree
```

FOUNDER ALLELE REPRESENTATION

Founder	Retention	%Representation	Target	Difference
24 M	0.500	7.936	2.511	-5.424
50 FL	0.000	0.000	5.023	5.023
82 F	0.500	8.036	2.511	-5.524
1 M	0.751	4.475	3.772	-0.707
7 F	0.910	19.598	4.571	-15.028
5 M	0.823	15.329	4.131	-11.197
11 F	0.734	4.450	3.687	0.763
30 F	0.244	1.293	1.228	-0.065
10 ML	0.872	5.357	5.023	-0.334
16 F	0.237	0.846	1.190	0.344
18 M	0.955	12.537	4.797	7.741
19 M	0.500	2.711	2.511	-0.199
76 M	0.500	4.548	2.511	-2.037
E30 M	0.256	1.354	1.283	-0.070
77 F	0.500	4.380	2.511	-1.869
35 ML	0.500	1.786	5.023	3.237
46 F	0.500	1.786	2.511	0.726
49 ML	0.000	0.000	5.023	5.023
66 FL	0.745	3.571	5.023	1.451
67 FL	0.000	0.000	5.023	5.023
138 FL	0.000	0.000	5.023	5.023
136 ML	0.000	0.000	5.023	5.023
137 FL	0.000	0.000	5.023	5.023
139 FL	0.000	0.000	5.023	5.023
T9010 ML	0.000	0.000	5.023	5.023
T9011 FL	0.000	0.000	5.023	5.023

GENETIC SUMMARY	LIVING DESCENDANT POPULATION	POTENTIAL
Number of founders:	17	26
Mean retention:	0.590	0.766
Founder genomes surviving:	10.027	19.910
Founder Equivalents:	9.588	23.045
Founder Genome Equivalents:	5.683	19.910
Fraction of wild gene diversity retained:	0.912	0.975
Fraction of wild gene diversity lost:	0.088	0.025
Mean inbreeding coefficient:	0.033	

RHINOCEROS UNICORNIS - NORTH AMERICA - 20-04-1992

ORDERED LISTS OF MEAN KINSHIP BY SEX:

Rank	MALES	MK	Known	FEMALES	MK	Known
1	49	0.0000	1.0000	50	0.0000	1.0000
2	136	0.0000	1.0000	67	0.0000	1.0000
3	T9010	0.0000	1.0000	132	0.0000	1.0000
4	35	0.0089	1.0000	137	0.0000	1.0000
5	125	0.0179	1.0000	135	0.0000	1.0000
6	10	0.0268	1.0000	T9011	0.0000	1.0000
7	69	0.0268	1.0000	66	0.0179	1.0000
8	53	0.0313	1.0000	79	0.0357	1.0000
9	106	0.0446	1.0000	T9012	0.0402	1.0000
10	126	0.0737	1.0000	151	0.0675	1.0000
11	147	0.0737	1.0000	161	0.0673	1.0000
12	T9009	0.0737	1.0000	29	0.0804	1.0000
13	87	0.0826	1.0000	89	0.0815	1.0000
14	83	0.0993	1.0000	45	0.0859	1.0000
15	164	0.0999	1.0000	60	0.1027	1.0000
16	T9013	0.1063	1.0000	162	0.1063	1.0000
17	101	0.1194	1.0000	99	0.1373	1.0000
18	116	0.1194	1.0000	130	0.1523	1.0000
19	146	0.1194	1.0000	143	0.1523	1.0000
20	180	0.1194	1.0000			
21	26	0.1406	1.0000			

GENETIC SUMMARY OF POPULATION

Descendant population mean kinship:	0.0878
Gene diversity:	0.9122
Founder Genome Equivalents:	5.6964

RHINO GLOBAL CAPTIVE ACTION PLAN WORKSHOP

BRIEFING BOOK

LONDON ZOOLOGICAL GARDENS
9-10 MAY 1992

SECTION 12

SUMATRAN RHINO

DRAFT

20 MARCH 1992

INTERNATIONAL STUDBOOK

FOR

SUMATRAN RHINO
(*Dicerorhinus sumatrensis*)

Compiled by:

Dr. Thomas J. Foose & Dr. Zainal Zahari Zainuddin

SUMATRAN RHINO Studbook
(*Dicerorhinus sumatrensis*)

Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death Date	Name	Breeder #
1	F	????	WILD	WILD	WMALAYSIA	30 Apr 1984	1	Wild Born			JERAM	MELAKA 1
					MALACCA	30 Apr 1984	1					
					SNG.DUSUN	13 Jan 1987	1		MALAYSIA			
					MALACCA	15 Aug 1987	1					
					SNG.DUSUN	31 May 1991	1		MALAYSIA			
2	M	- 1984	WILD	WILD	WMALAYSIA	1 May 1984	UNK	Wild Born			ERONG	MELAKA 2
					MALACCA	1 Jun 1984 (died)				1 Jun 1984		
3	F	????	WILD	WILD	WMALAYSIA	18 Apr 1985	2	Wild Born			MELINTANG	MELAKA 3
					MALACCA	18 Apr 1985	2					
					BANGKOK	- Jul 1986	UNK		THAILAND			
						- Nov 1986 (died)				- Nov 1986		
4	M	????	WILD	WILD	SUMATRA	25 Nov 1985	UNK	Wild Born	INDONESIA		TORGAMBA	LYMPNE 1
					LYMPNE	5 Apr 1986	UNK		ENGLAND			
5	F	????	WILD	WILD	SUMATRA	23 Jan 1986	UNK	Wild Born	INDONESIA		ITAU	
						24 Jan 1986 (died)				23 Jan 1986		
6	M	????	WILD	WILD	SUMATRA	2 Feb 1986	UNK	Wild Born	INDONESIA		ROKAN	SURBYA 1
					SURABAYA	- May 1988	UNK		INDONESIA			
7	F	????	WILD	WILD	WMALAYSIA	10 Feb 1986	3	Wild Born			RIMA	MELAKA 4
					MALACCA	10 Feb 1986	3					
					SNG.DUSUN	13 Jan 1987	3		MALAYSIA			
					MALACCA	6 Mar 1987	3					
8	M	????	WILD	WILD	SUMATRA	23 Mar 1986	UNK	Wild Born	INDONESIA		JALU	JAKART 1
					JAKARTA	24 May 1986	UNK		INDONESIA			
9	M	????	WILD	WILD	SUMATRA	15 Jun 1986	6	Wild Born	INDONESIA		NAPANGGA	MELAKA 5
					MALACCA	25 Apr 1987	6					
						6 Aug 1987 (died)				6 Aug 1987		
10	F	????	WILD	WILD	SUMATRA	22 Jun 1986	UNK	Wild Born	INDONESIA		SUBUR	LYMPNE 2
					LYMPNE	25 Aug 1986	UNK		ENGLAND			
						30 Oct 1986 (died)				30 Oct 1986		
11	F	????	WILD	WILD	WMALAYSIA	6 Jul 1986	4	Wild Born			JULIA	MELAKA 6
					MALACCA	6 Jul 1986	4					
					SNG.DUSUN	13 Jan 1987	4		MALAYSIA			
					MALACCA	21 Apr 1989	4					
						15 Dec 1989 (died)				15 Dec 1989		
12	F	????	WILD	WILD	WMALAYSIA	9 Sep 1986	5	Wild Born			DUSUN	MELAKA 7
					MALACCA	9 Sep 1986	5					
					SNG.DUSUN	13 Jan 1987	5		MALAYSIA			
					MALACCA	6 Mar 1987	5					
					JAKARTA	25 Apr 1987	UNK		INDONESIA			

SUMATRAN RHINO Studbook
(Dicerorhinus sumatrensis)

Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
13	F	~ 1983	WILD	WILD	WMALAYSIA	25 Feb 1987	7	Wild Born			PANJANG	MELAKA 8
					SNG.DUSUN	25 Feb 1987	7		MALAYSIA			
					MALACCA	5 Mar 1987	7					
					SNG.DUSUN	25 Sep 1987	7		MALAYSIA			
					MALACCA	20 Apr 1989	7					
					SNG.DUSUN	27 Apr 1991	7		MALAYSIA			
14	M	????	WILD	WILD	SABAH	26 Mar 1987	UNK	Wild Born	MALAYSIA			
						26 Mar 1987 (died)				26 Mar 1987		
15	F	23 May 1987	WILD	7	MALACCA	23 May 1987	8	Captive Born			MINAH	MELAKA 9
16	F	????	WILD	WILD	WMALAYSIA	1 Jul 1987	9	Wild Born			SERIDELIMAMELAKA10	
					MALACCA	1 Jul 1987	9					
						23 Sep 1988 (died)				23 Sep 1988		
17	M	????	WILD	WILD	SABAH	14 Jul 1987	UNK	Wild Born	MALAYSIA		TANEGANG	SEPLOK 1
					SEPILOK	14 Jul 1987	UNK		MALAYSIA			
18	F	????	WILD	WILD	SUMATRA	21 Jul 1987	UNK	Wild Born	INDONESIA		MERANTI	LYMPNE 3
					LYMPNE	30 Apr 1988	UNK		ENGLAND			
19	F	????	WILD	WILD	WMALAYSIA	26 Aug 1987	10	Wild Born			MAS MERAH	MELAKA11
					MALACCA	26 Aug 1987	10					
					SNG.DUSUN	2 May 1991	10		MALAYSIA			
20	M	~1984 +/-1yr	WILD	WILD	WMALAYSIA	26 Mar 1988	11	Wild Born			SHAH	MELAKA12
					MALACCA	26 Mar 1988	11					
					SNG.DUSUN	2 May 1991	11		MALAYSIA			
21	M	????	WILD	WILD	SABAH	24 May 1988	UNK	Wild Born	MALAYSIA			
						25 May 1988 (died)				25 May 1988		
22	F	????	WILD	WILD	SUMATRA	8 Jul 1988	UNK	Wild Born	INDONESIA		DALU	BOGOR 1
					TAMNSAFAR	30 Nov 1988	UNK		INDONESIA			
23	F	????	WILD	WILD	WMALAYSIA	11 Jul 1988	12	Wild Born			SEPUTIH	MELAKA13
					MALACCA	12 Jul 1988	12					
					SNG.DUSUN	31 May 1991	12		MALAYSIA			
24	F	????	WILD	WILD	SUMATRA	22 Jul 1988	UNK	Wild Born	INDONESIA		MAPATO	CINC 1
					LOSANGELE	25 Nov 1988	UNK		U.S.A.			
					CINCINNAT	5 Jun 1989	UNK		U.S.A.			
25	F	????	WILD	WILD	SUMATRA	24 Jul 1988	UNK	Wild Born	INDONESIA		KUMU	SANDGO 1
					SANDIEGOZ	25 Nov 1988	UNK		U.S.A.			
26	F	????	WILD	WILD	SABAH	22 Apr 1989	UNK	Wild Born	MALAYSIA		LUN PARAI	SEPLOK 2
					SEPILOK	22 Apr 1989	UNK		MALAYSIA			

SUMATRAN RHINO Studbook
(Dicerorhinus sumatrensis)

Stud #	Sex	Birth Date	Sire	Dam	Location	Date	Local ID	Birth-Origin	Country	Death-Date	Name	Breeder #
27	F	26 Aug 1989	WILD	WILD	SUMATRA	26 Aug 1989	UNK	Wild Born	INDONESIA		RAPUNZEL	BRONX 1
					LOSANGELE	29 Nov 1989	UNK		U.S.A.			
					NY BRONX	16 May 1990	UNK		U.S.A.			
28	M	????	WILD	WILD	SUMATRA	23 Jul 1990	UNK	Wild Born	INDONESIA		RAGUS	CINC 2
					SANDIEGOZ	10 Apr 1991	UNK		U.S.A.			
					CINCINNAT	25 Oct 1991	UNK		U.S.A.			
29	F	????	WILD	WILD	SUMATRA	6 Mar 1991	UNK	Wild Born	INDONESIA		IPAK	LA 1
					LOSANGELE	23 Nov 1991	UNK		U.S.A.			
30	M	????	WILD	WILD	SUMATRA	18 Apr 1991	UNK	Wild Born	INDONESIA		ROMI	BOGOR 2
					TAMNSAFAR	2 Sep 1991	UNK		INDONESIA			
31	M	????	WILD	WILD	SABAH	5 May 1991	UNK	Wild Born	MALAYSIA		TAKALA	SEPLOK 3
					SEPILOK	5 May 1991	UNK		MALAYSIA			
32	F	????	WILD	WILD	SUMATRA	17 May 1991	UNK	Wild Born	INDONESIA		BINA	BOGOR 3
					TAMNSAFAR	2 Sep 1991	UNK		INDONESIA			
33	F	????	WILD	WILD	SUMATRA	12 Jun 1991	UNK	Wild Born	INDONESIA		RAMI	SRT 1
					SANDIEGOZ	23 Nov 1991	UNK		U.S.A.			
34	F	17 Jan 1992	WILD	WILD	SUMATRA	17 Jan 1992	UNK	Wild Born	INDONESIA			
35	M	20 Mar 1992	WILD	WILD	SUMATRA	20 Mar 1992	UNK	Wild Born	INDONESIA			SANDGZ2

TOTALS: 13.22.0 (35)

Compiled by: Dr. T.J. Foose & Dr. Zainal thru Captive Breeding Specialist Group
Data current thru: 20 Mar 1992 Draft International Studbook

SPARKS v1.11
27 Apr 1992

SUMMARY - CAPTIVE PROGRAMS
SUMATRAN RHINO - 1984 TO 1992

COUNTRY	CAPTURED	BORN	IMPORTED	EXPORTED	DIED	ALIVE
P. MALAYSIA	2/9	0/1	1/0	0/2	2/2	1/6
SABAH	4/1	0/0	0/0	0/0	2/0	2/1
INDONESIA	7/11	0/0	0/1	3/7	0/1	4/4
THAILAND	0/0	0/0	0/1	0/0	0/1	0/0
U.K.	0/0	0/0	1/2	0/0	0/1	1/1
U.S.A.	0/0	0/0	1/5	0/0	0/0	1/5
TOTAL	**13/21**	**0/1**	**3/9**	**3/9**	**4/5**	**9/17**

T.J. Foose
20 March 1992

LIVING SUMATRAN RHINOCEROS IN CAPTIVITY

(20 March 1992)

COUNTRY	INSTITUTION	MALES	FEMALES	TOTAL
Indonesia	Jakarta	1	1	2
	Surabaya	1		1
	Taman Safari	1	2	3
	Ipuh	1	1	2
	Subtotal Indonesia	*4*	*4*	*8*
Malaysia				
Peninsula	Malacca	0	2	2
	Sungai Dusun	1	4	5
	Subtotal P. Malaysia	*1*	*6*	*7*
Sabah	Sepilok	2	1	3
	Subtotal Sabah	*2*	*1*	*3*
United Kingdom	Port Lympne	1	1	2
	Subtotal U.K.	*1*	*1*	*2*
United States	Cincinnati	1	1	2
	Los Angeles	0	1	1
	New York	0	1	1
	San Diego	0	2	2
	Subtotal U.S.A.	*1*	*5*	*6*
WORLD TOTAL		9	17	26

SUMATRAN RHINO MORTALITY BY YEAR
1984 - 1992

	1984	1985	1986	1987	1988	1989	1990	1991	1992
Captures	2	2	8	6	6	2	1	2	2
Births	0	0	1	0	0	0	0	0	0
Deaths	1	0	3	2	2	1	0	0	0
Population at Risk	2	3	11	15	19	19	19	24	26
% Mortality	50	0	27	13	11	5	0	0	0

T.J. Foose
20 March 1992

SUMATRAN RHINO
MORTALITY SUMMARY
BY COUNTRY OF ORIGIN
1984-1992

	CAPTURED	DIED	% MORTALITY	LAST DEATH
Indonesia	18	3	17	1987
P. Malaysia	11	4	36	1989
Sabah	5	2	40	1988
Total	**34**	**9**	**26**	

T.J. Foose
20 March 1992

SUMMARY OF MORTALITY
SUMATRAN RHINO IN CAPTIVITY
1984-1992

Animal	Sex	Date & Place of Capture	Date & Place of Death	Date to Death Place	Cause of Death	Condition & Age at Capture
2 Erong	M	01-05-84 Malaysia	01-06-84 Malacca	01-05-84	Inanition	Poor/Calf (est. 3 mo.) Discovered abandoned in Jungle
3 Melintang	F	18-04-85 Malaysia	15-11-86 Bangkok	00-07-86	Accident: Ensnared Neck in Enclosure	Good/Adult
5 Riau	F	23-01-86 Sumatra	23-01-86 Sumatra	23-01-86	Accident: Died of Trauma in Corral Trap	Good/Adult
9 Napangga	M	15-06-86 Sumatra	06-08-87 Malacca	25-04-87	Acute Colic	Poor/Adult
10 Subur	F	25-06-66 Sumatra	30-10-86 England	25-08-86	Digestive	Marginal/Adult
11 Julia	F	06-07-86 Malaysia	15-12-89 Malacca	06-07-86	Cecal Impaction	Good/Adult
14	M	26-03-87 Sabah	26-03-87 Sabah	26-03-87	Capture Trauma	?/Adult
16 Seridelima	F	01-07-87 Malaysia	23-09-88 Malacca	01-07-87	Salmonella	Marginal/Adult
21	M	24-05-88 Sabah	25-05-88 Sabah	24-05-88	Capture Trauma	?/Adult

T.J.Foose
1 February 1992

RHINO GLOBAL CAPTIVE ACTION PLAN WORKSHOP

BRIEFING BOOK

LONDON ZOOLOGICAL GARDENS
9-10 MAY 1992

SECTION 13

SYSTEMATICS

Captive Breeding Specialist Group

Species Survival Commission
IUCN – The World Conservation Union

U. S. Seal, CBSG Chairman

2 April 1992

TO: *CBSG Ad Hoc Advisory Group on "Subspecies Questions":*
George Amato, John Avise, Joel Cracraft, Matthew George, Bob Lacy, Russ Lande, Gary McCracken, Steve O'Brien, Ollie Ryder, Bob Wayne

FROM: Tom Foose

SUBJECT: **"SUBSPECIES" OF BLACK RHINO**

Attached are a number of reports and publications relating to the genetic structure of populations of black rhino (*Diceros bicornis*). Summary papers providing an overview of currently described and recognized "subspecies" or "e.s.u.'s" are also included. Of particular concern is the distinction between black rhino of East African origin (i.e. the so-called *D.b. michaeli* from Kenya and northern Tanzania) and rhino of Southern African origin (*D.b. minor* from Zimbabwe and the Republic of South Africa).

Would you please review these materials with respect to 2 questions:

(1) Does the genetic data currently presented support attempts to conserve *D.b. michaeli* and *D.b. minor* as separate populations?

(2) What further specific studies would test the hypotheses that these populations have or have not diverged sufficiently to justify conservation as separate population?

Within a week from today, I may be transmitting by fax a summary of some further data on the subject from George Amato.

It would be useful and appreciated if you could respond by 27 April. Thanks so much.

cc: Ed Maruska, Don Farst, Bob Reece

12101 Johnny Cake Ridge Road, Apple Valley, MN 55124, USA tel. 612-431-9325 fax 612-432-2757
(home) 9801 Pillsbury Ave. S., Bloomington, MN 55420, USA tel. 612-888-7267 fax 612-888-5550

NEW YORK ZOOLOGICAL SOCIETY

Dr. Thomas J. Foose
CBSG
12101 Johnny Cake Ridge Road
Apple Valley, MN 55124

April 6, 1992

Dear Tom,

The following is a summary of recent, continued data gathering on *Diceros bicornis*. The final results will be presented at the Evolution Society meetings at Berkeley in June. Naturally, all of the raw data and portions of the samples are available to anyone who is interested.

1. Tony Lynam who has been doing excellent work with David Woodruff with mammals in Thailand identified different cytochrome B sequences in a "northern" and "southern" black rhino while working with Ollie Ryder. I have sequenced this gene (as well as two others and portions of the D-loop) in five rhinos sampled in the field in Zimbabwe and five animals in zoos that originated or are descendants of rhinos from Kenya. There is some variation in the sequence, but I have not found a sequence that characterizes North and South. There are three (and in some cases four) positions that are polymorphic in this gene, but they are not the same positions in the different animals.

2. Even in the very conserved 12S ribosomal gene I have found a one base change in the sequence of one individual of Kenyan origin. This is no more different from Zimbabwe animals then from other Kenyan animals.

3. I have been generating RAPD (randomly amplified polymorphic DNA markers) profiles on a larger set of black rhinos with a variety of 10 base oligonucleotide primers. The variation ranges from a primer that is species specific (all *D. bicornis* have the same pattern which is different from other species of rhino) to primers that generate unique patterns for all individuals. I have not yet found a primer that identifies a sequence that is unique to Southern versus Northern though some related animals (mother/offspring) have more similar patterns with one primer.

4. The pattern with the Sumatran rhinoceros is a very different story, and I will discus that with you when I see you.

George Amato, NYZS

BRONX, NEW YORK 10460 TELEPHONE 212-220-5100 TELEX 428279 NYZWTH

NEW YORK ZOOLOGICAL PARK/BRONX ZOO • NEW YORK AQUARIUM • WILDLIFE CONSERVATION INTERNATIONAL
CENTRAL PARK ZOO • OSBORN LABORATORIES OF MARINE SCIENCES • ST. CATHERINES ISLAND WILDLIFE SURVIVAL CENTER

CONSERVATION EDUCATION RESEARCH

APR 1992

UIC
College of Medicine at Chicago

Department of Anatomy and Cell Biology (M/C 512)
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(312) 996-6791

9 April 1992

FAX: 612-432-2757

Dr. Thomas Foose
Captive Breeding Specialist Group
12101 Johnny Cake Ridge Road
Apple Valley, Minnesota 55124

Dear Tom:

Thanks very much for giving me a chance to comment on the rhino papers. I am very much interested in the "subspecies problem" and actually discussed the Ashley et al. paper briefly at the felid TAG meeting.

For about ten years now I have thought and written about species concepts and what they mean for speciation analysis. At last year's meetings of the Society of Conservation Biology I presented a paper proposing that the phylogenetic species concept is far more appropriate for conservation biology than is the biological species concept. Summarizing briefly, phylogenetic species are those populations that are diagnosably distinct, and thus they are equivalent to what conservation biologists call "evolutionary significant units." Taxa of subspecies rank within the context of the BSC encompass all kinds of things, from arbitrary segments of clinal variation to diagnosably distinct units. One unfortunate consequence of BSC thinking is the view that it is the amount of subspecies difference that must be assessed before we can say whether they are evolutionary significant units (and this is an issue with the rhinos). Thus, under the BSC it is the amount of difference among allopatric populations which allows us to specify whether they are subspecies or species. I believe this approach will lead to innumerable arguments over whether differences are "sufficient" or not (and the systematic literature is littered with such discussions). The PSC does not have this problem because the criterion is diagnosability.

The above discussion is not meant to cover all the details of arguments over species concepts but to give you a flavor of my approach to the problem. I will send you some papers under separate cover. These debates need not necessarily create problems for the conservation community as long as we are all agreed that what we are seeking is to identify those populations (subspecies, if one prefers) that are diagnosably distinct. The line of thinking we should avoid, I think, is judging whether populations are *different enough* to warrant calling them evolutionarily significant units. If they are distinct, then we are justified in calling them historical (or evolutionary) units.

Within the context of the above discussion, I see the present evidence regarding the diagnosability of the black rhino subspecies as supporting the distinctness of *D. b. minor* and *D. b. michaeli*. Table 3 of Ashley et al. indicates that they differ by three restriction sites for the enzymes BclI, HinfI, and TaqI. What are we to make of these data? If one looks at the results shown in their Table 2, we see only one enzyme showing a polymorphic restriction site pattern within *D. b. minor* (EcoRI). Table 2 suggests polymorphism is uncommon (only 1 out of 11 enzymes). Table 3, on the other hand, raises a problem because sample sizes for all three populations are as small as they can get. Yet the two *D. b. minor* individuals are identical and differ from that of *D. b. michaeli*. Clearly the two subspecies are very close genetically, and it is from this observation that I think Ashley et al. make several problematic conclusions:

1. "Thus, there is no evidence from these data that the black rhinos we sampled represent 'evolutionarily distinct units" (p. 75), and

2. "At the national level, the level at which management decisions are currently made, the pooling of black rhinos carries with it little risk of mixing distinct genetic adaptations *worthy* [italics mine] of separate conservation efforts.' (p. 76).

To their first point, I disagree. The evidence is consistent with the hypothesis that there are two distinct historical lineages. Now, it may turn out that after more individuals are sampled for those three enzymes that all three will be polymorphic in one or both populations. But what if they are not? Given the virtual absence of polymorphism in the other enzymes (enzymes that have a higher probability of showing polymorphism than do the four- or five-base cutters of Table 3), my bet is that they will remain diagnostic.

To their second point, let me raise a more serious, fundamental objection. I question whether it is possible to define "distinct genetic adaptations" and specify how to recognize them. This phrase —distinct genetic adaptations— is so nonoperational that it should not be the basis for management decisions. Moreover, one could apply this type of reasoning to all sorts of distinct populations with unacceptable consequences for most conservation biologists. I think this is an example of the thinking I mentioned above: if two populations are not different *enough*, then they couldn't possibly have "distinct genetic adaptations." But really, it only takes one mutation for that to happen—any geneticist could cite examples. It is because of these ambiguities in language that I also object to the term "evolutionarily *significant* units." I just don't like the word "significant" and am wary that it could be used to support mixing distinct taxonomic units even though they are not "significantly" different from one another.

Where does this leave us? There are several options. One I find troublesome: buy into the argument that they are not distinct enough to warrant the time and expense of trying to manage two separate entities. It is troublesome to me because of its implications for many other species. Another option, to attempt to confirm whether they are distinct, recognizing they will be minimally diagnostic in any case. As a systematist, if they are minimally diagnostic, they still represent separate historical entities. I think the work of Ollie Ryder and his group on karyology is consistent with the meagre mtDNA data that these subspecies are likely distinct. At the very least, both data sets argue strongly for more research on the problem before implementing any management program that involves mixing the two subspecies.

I hope these observations are of some use.

Best,

Joel Cracraft

APR 2 0 1992

THE UNIVERSITY OF TENNESSEE
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16 April 1992

Dr. Tom Foose
CBSG
12101 Johnny Cake Ridge Rd.
Apple Valley, MN 55124

Dear Tom:

I've reviewed the information that you sent regarding the D.b. michaeli and D.b. minor subspecies question.

The mtDNA results from the work of Ashley et al. (1990), Harley and O'Ryan (1991), and Amato et al. show little sequence divergence (.29 - .4%) between these putative subspecies and suggest, as the authors state, that on this basis subspecies recognition does not seem warranted. I agree with that assessment from those data. The information in the FAX from Amato reporting the work in his lab on cytochrome B sequences, the 12S ribosomal gene, and the RAPD profiles is consistent with the results of the mtDNA studies; again, suggesting no molecular genetic evidence to warrant subspecies recognition.

On the other hand, the information on chromosome structure from Ollie Ryder's lab indicates that there may be consistent differences between the putative subspecies with D.b. minor having substantially fewer chromosome arms than D.b. michaeli. These chromosome studies are very limited with regard to sample sizes and the sampling of different geographic populations; however, the available chromosome data do appear to conflict with the molecular genetic data.

The existing morphological data do not help in resolving the issue. There clearly are differences in skull size and measurements, with some evidence of clinal variation. However, in the Groves paper, the standard deviations of the measurements from skulls of adults from the two subspecies overlap in all measurements. The value of existing morphological studies appears compromised because of the pooling of sexes and imprecise geographical information.

My assessment is that the issue is not as clear as the molecular studies appear to suggest. Despite the molecular genetic information, I believe that the conservative approach of continuing to treat these as separate sets of populations is best, at present.

While I will not be at all surprised if the subspecies distinctions are not warranted, I do not think that decision should be made until there is a more complete set of data on the possible distinctive chromosome morphs and a more rigorous examination of the patterns of morphological variation among the different sets of populations. I'm also struck by the apparent absence of any comparative information on ecology and behavior in these two putative subspecies. Certainly ecological and behavioral studies could contribute to the resolution of this issue.

I hope this provides the input you requested. Feel free to contact me if I can assist further. My office phone # is 615-974-6194, FAX 615-974-0978.

Sincerely,

Gary

Gary F. McCracken
Professor

APR 2 7 1992

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April 18, 1992

Mr. Tom Foose
AAZPA Conservation Director
Minnesota Zoo
12101 Johnny Cake Ridge Road
Apple Valley, MN 55124

Re: Sub-species of Black Rhino

Dear Tom:

From all that I have been able to glean from the literature, the black rhino, Diceros bicornis, has had a contiguous population across the African continent for at least a million years. (Even in the fossil Pliocene remains discovered, dating 4-5 million years ago, the differences from extinct to extant forms are minimal).

During historical times the black rhino has populated Africa from south of the Sahara to the Cape without any truly definably isolated populations. It is only recently that these populations have been fractured or eliminated. Obviously this fact alone does not certainly justify ignoring the geographical variations or clines within an overall population. There appears to be no phenotypic differences in the vast array of photos that I have in our files. By coupling this fact with recent findings in a wide range of museum specimens, that the morphological differences are not significantly greater than that which one would find in a single geographic population is strong evidence for lumping these sub-species into one.

We have all patiently waited for the biochemical results to be analyzed and from what I can discern from the various reports, there doesn't seem to be a great deal of differences that can be demonstrated between the populations of East, michaeli and the Southern, minor. On biological grounds it would be my recommendation that we recognize only one population of black rhino. Should other sub-species become available which biochemical analysis would demonstrate clear differences, then and only then, should the topic be re-visited.

However, having said that, practically speaking, politically we may be dealing with another animal or animals. At the Cincinnati Conference we agreed to recognize "evolutionary significant units" until such time that the state of the art systematics could be worked out with this species by various experts in the field and laboratories. We (AAZPA members) were strong proponents of keeping at least several of these populations separated. For some of us this was more of a political move than it was a biological one and perhaps we should be discussing how we deal with Zimbabwe on this issue rather than spending a great deal of time on the sub-species question itself. I personally have a feeling that it may actually be detrimental to the captive management of this species long term if we are to maintain several captive populations. It would be a distinct advantage of time and space if we treated this species as one population.

Please feel free to call if you want to discuss this matter further.

My sincere regards,

Dr. Edward J. Maruska
Executive Director

cc: Robert Reece
Don Farst
Betsy Dresser

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Wed, Apr 22, 1992

Dr. Tom Foose, CBSG, 12101 Johnny Cake Ridge Rd.
Apple Valley, MN 55124 USA
FAX: 0101-612-432 2757

Dear Tom:

Based on general principles in Lande & Barrowclough (1987 in M. Soule (ed.), Viable Populations for Conservation) and the information you sent on rhino population genetics, I have the following opinions concerning management of *D. b. michaeli* and *D. b. minor* as separate populations, and specific studies that would help to clarify whether separate management is justified.

In the absence of genetic data, or even with abundant molecular and chromosomal data showing close similarity between two allopatric populations, there is still a distinct possibility of local adaptation in morphological, behavioral, and/or physiological traits which would justify separate management if populations are to be maintained or reconstituted in local areas. Such adaptation is likely in the case of populations that differ sufficiently in morphological traits to be designated as subspecies, unless there is a strong feeling among experts that the taxonomic splitting is unjustified.

The molecular data on *D. b. michaeli* and *D. b. minor* indicate a level of genetic differentiation less than that among other typical mammalian subspecies, however they also indicate that rhino species differ in this respect less than other typical congeneric species of mammals. The appropriate standard on which to assess the molecular genetic distance between rhino subspecies is the genetic distance among rhino species, not among species of other taxa. From my recollection of data on other taxa, it seems likely that the genetic distance between the rhino subspecies as a fraction of the genetic distance among rhino species is not much smaller than such a proporional measure of subspecific differentiation for other taxa.

The chromosomal evidence definitely needs more detailed investigation. So far, only counts of chromosome numbers and arm numbers are available. The variation within and among taxa is interesting, but not alarming, unless further banding studies of the chromosomes can demonstrate that these changes are caused by pericentric inversions, mutliple centric fusions and fissions, or more unusual types of rearrangements. Since the chromosome numbers are not variable in the sample studied, it seems likely that the extra arms are heterochromatic, which I would expect to cause little if any problems in hybridization.

In summary, the current genetic evidence does not indicate that any serious genetic problems would be manifest upon hybridization. However, the subspecific status, if thought to be valid on classical taxonomic grounds (with respect to the standard of rhino species differences), supports separate management, unless practical considerations strongly dictate otherwise. Chromosomal banding studies need to be done. Any evidence on ecological differences between subspecies, manifested in morphology, behavior or physiology would be particularly important in indicating possible adaptive differentiation between the subspecies.

Sincerely,

Russell Lande

Russell Lande
Professor

To: Tom Foose
From: Bob Lacy
Re: rambling thoughts on black rhino subspecies

8 April 1997

The available data are not yet sufficient to be absolutely convincing, but they certainly do not bode well for splitters. The molecular data suggest very recent, if any, divergence among the subspecies. The chromosomal data do suggest some divergence (probably of a non-adaptive sort), but more samples should be analyzed to get a better picture of within-subspecies variation. I fully agree with several of the papers, which state that there is a minimal probability of any outbreeding depression if the "subspecies" were to be crossed.

Should the forms be crossed? In the wild populations, I know of no advantage that would be gained by doing so. The disadvantages are real, but have nothing to do with genetics. I don't expect any genetic effect of such crossing. The populations have not gone through such small bottlenecks that minor or michaeli would have lost much variation across the subspecies -- so between-subspecies crosses should not be necessary to reverse inbreeding. Nor are the differences large enough to warrant fears of outbreeding depression were they to be crossed. Even if some small amount of divergence has occurred, the amount of divergence is trivial compared to between-population differences that cause no outbreeding depression in other mammals.

Because of political, disease, and logistic considerations, however, I would think that crosses between subspecies in the wild would be avoided.

In captivity, again there is no genetic reason to avoid crosses. There may, however, be sound reasons to prefer crossing the subspecies in captivity, or at least not to maintain full breeding programs for each. Any possible outbreeding depression (however unlikely) would be a result of local adaptations -- these would be irrelevant to captive breeding programs and, probably, for reintroduction programs as well. Population supplementation into wild habitats would most logically use translocated animals, which would presumably be of the same subspecies. The only need I can envision for undertaking the considerable task of releasing zoo rhinos would be if the disaster occurred: rhinos were eliminated from large areas of range in Africa. If the restocking of east Africa, say, had to be done with zoo rhinos, I would expect that a subspecies-soup rhino population would be as useful as would any captive population derived solely from one geographic area. In fact, to allow maximal opportunity for disease resistance, and continuing adaptation, a subspecies-soup might be the best population to use for reestablishment. Note that black rhinos don't have much variation, and do show particular susceptibility to diseases, for which there is thought to be a genetic predisposition.

As the ultimate back-up populations, zoo stocks do not seem to me to be good places to try to preserve subtle genetic differences that may have something to do with local adaptations. I would rather aim for healthy, genetically diverse zoo populations that contain much of the variation that once existed across the range of an interbreeding population. (Given the historical patterns of distribution, I have a hard time believing that black rhino populational divergence would be anything other than clinal variation.)

As for non-genetic considerations: I don't buy the geopolitical subspecies concept for conservation purposes. If people and governments only cared about latin trinomials, then why would Tanzania, for example, bother to protect their (non-unique) rhinos? why would Kenya protect elephants? why would the U.S. protect grizzly bears? People work to protect their natural heritage (perhaps so they can make money from it), generally regardless of whether the same taxon might exist in another land. To argue that the conservation of a geographic population should be based on its taxonomic distinction from other populations would leave one quite vulnerable to the argument (made by some in southern Africa) that international agreements (e.g., CITES) should not bother to protect Kenyan elephants and rhinos. Taxonomic splitting for the purpose of furthering local conservation can backfire when the molecular data come in.

Beyond doing the appropriate studies to be sure that cryptic species (e.g., owl monkey karyotypic forms) are not overlooked, I do not see why zoos should create populational barriers that are more absolute and long-lasting than those that existed in nature (before the massive habitat fragmentation caused by humans).

What further data are needed? The chromosomal divergence should be investigated further, with better sampling of within-taxon variation. Any further molecular (DNA, allozyme) work would be of interest, although at this point it looks increasingly unlikely to reveal substantial differences. Mitochondrial DNA is very rapidly evolving. If it hasn't noticeably diverged, it is unlikely that much else has either.

Take care,

Bob

To: Tom Foose 25 April 1992
From: Bob Lacy
Re: Black rhino subspecies

Here is a further elaboration of my rambling thoughts concerning the need or desire to keep black rhino subspecies or populations as distinct ESUs in captive programs. As before, I have not tried to be concise; rather, I let my fingers keep typing away in an attempt to get my views down on paper.

As I pointed out in my previous memo to you, I question the wisdom of maintaining discrete black rhino populations in zoos. My view arises from considerations about (1) what is possible, both economically and biologically, in captive breeding programs, (2) the patterns of genetic variation among natural populations, rhino and otherwise, and (3) the lack of evidence that large mammal populations are finely adapted to local environments.

First, zoos will not be capable of protecting the full range of genetic variation, partitioned in its natural pattern, of many (or perhaps any) species. Zoos can serve a very valuable conservation purpose in preventing the extinction of species, or of maintaining levels of genetic variation (for eventual return to the wild) that might be lost from tiny, remnant populations persisting in the fragments of the wild that will survive. For example, captive breeding can (we hope) prevent the final loss of the Florida panther gene pool. Similarly, captive breeding programs have been essential in restoring Arabian oryx and other species to the wild. However, zoos cannot protect all genetic variation in a taxon. To do so would require not only captive population sizes that approach (and sometimes exceed) the size of wild populations, but also the creation of artificial habitats for captive breeding that mimic the full range of habitats utilized by the wild populations. To protect, in captivity, the subtle adaptive and non-adaptive genetic differences found among natural populations would require a multitude of breeding programs for each species and, if preservation in captivity is needed for more than a generation or two, environments that preserve the selective regimes that led to the divergence among the wild populations. Recall that the theory and modelling that direct our captive breeding programs assume random genetic changes among neutral genes, and pay little attention to modest shifts in allele ferequencies. The requirements for maintaining relatively unchanged the structure of genetic variation among multiple subpopulations are likey to be excessive.

While captive populations can retain genetic variants that are adaptive in some environments (though perhaps not in captivity), they would not retain the genetic variation in the same frequencies, nor with the same spatial structure, nor with the same genetic linkage groups that have evolved in wild habitats. The best that can be done is to retain a somewhat altered but not wholly depleted pool of genetic variation -- but that is probably all that would be needed or desired. Reintroduced stocks would probably be going into altered biological and physical environments; hence, they would benefit most from the presence of many genetic variants that came from populations adapted to a range of local environments. Even if the environment were to remain unchanged, a genetically diverse stock (a population "soup") would probably have at least as good of an opportunity to survive and thrive as would a stock that contained only genes that came originally from that site. There is increasing evidence that some natural populations (especially those most likely to need bolstering from captive stock) are suffering decreased fitness and adaptability because of diminished genetic variation.

Natural populations are not panmictic. Geographic patterns of genetic variation abound. Clines, sharp discontinuities in some traits, and mosaic patterns of variation exist for many species. Although the data are still a bit scant, it appears that the variation in black rhinos is very minor and primarily clinal. I would guess, for example, that the variation among geographic populations of black rhinos is trivial compared to the variation among human races. Moreover, given the historical distribution of rhinos, it is likely that the genetic variation consists of shifts in allele frequencies, not a great many fixed genetic differences. In other words, it would be possible, in the appropriate selective setting and with some time, to recreate each of the gene pools that exist today from any one of the other gene pools. By modern systematic methods, the variation observed across the range of black rhinos would not lead to the designation of subspecies. There would need to be a demonstration of concordant and statistically significant variation in a number of traits, with discontinuities or at least sharp clines, before there would be reason to erect subspecies names. People laugh at the incredible numbers of subspecies that had been declared for some mammals and birds, based on very little evidence. Yet the relatively few subspecies of rhinos are not supported by any better data.

To protect as discrete gene pools all populations that have diverged to the extent seen in the black rhino "subspecies" would require protection of 100s of populations each of many other mammal species. Rhinos are spectacular (even a mouse biologist like myself gets excited at seeing one of those beasts), but their biology makes them incredibly poor candidates for developing significant local adaptations. The data support this view: black rhinos show relatively little genetic variation across the species range. It is possible that further studies will reveal a striking, discontinuous pattern of adaptive variation in black rhinos (although I cannot imagine that the right combination of limited gene flow, selective differences, and ecological specialization exists to promote the evolution of such patterns). For that reason it might be argued that, to be safe, the black rhino populations should not be mixed in captivity. Yet, by the same reasoning, for every species we could arbitrarily partition the breeding programs into ever smaller units on the presumption that significant differences may some day be found. I remind you that the currently named rhino subspecies are not well supported by the evidence. If significant discontinuities in the black rhino gene pool are found, I would be surprised if it happened to coincide with the range boundaries of the named subspecies.

Evolutionary biologists frequently employ techniques for partitioning the genetic variance of a species into within and between population components. If the between-population component is quite small, it is generally recognized that little adaptive divergence among local populations is likely. The presence of some detectable between-population component does not impress me, as it can be found between almost any two natural populations of any species and is expected on the basis of genetic drift in any non-panmictic population. In fact, the total lack of such population structure is the more notable finding in evolutionary studies. Lacking a demonstration of a significant, larger than usual, between-population component to variation, I would not recommend the development of costly duplicate programs for maintaining isolated stocks in captivity.

I am especially critical of conservation programs that erect barriers to gene flow at some arbitrary line within a range across which a species shows continuous, clinal variation, without concordance among traits. The line separating the "populations" could be drawn almost anywhere and will create a barrier to gene flow that did not exist previously. For example, it is inconceivable that Florida panthers (Felis concolor coryi) did not interbreed with adjacent subspecies (e.g., at the TN-KY border) in the past. It is equally inconceivable that black rhinos never crossed the "line" between the ranges of the minor and michaeli subspecies.

I recognise that there has been much discussion recently about "outbreeding depression" and "optical inbreeding". With the exception of a few strongly differentiated populations that should be considered full biological species, there is almost no evidence for outbreeding depression in a mammal (or bird) species. The converse, inbreeding depression within local populations and hybrid vigor in inter-populational crosses is much more common. The cases in which genetic divergence sufficient to cause "outbreeding depression" has been observed (e.g., owl monkeys, some small antelopes) are cases in which the genetic divergence is orders of magnitude greater than yet demonstrated in rhinos. Within most local populations of mammals we see more genetic divergence than is seen across the whole range of black rhinos.

Still, recognizing that substantial genetic divergence can go unnoticed when only morphological traits are examined, I would recommend that populations from geographically distant and disjunct populations not be mixed until some molecular genetic studies (such as those done on the rhinos) are completed. Differences such as those seen between the two orang utan subspecies may well be biologically significant, and have an obvious biogeographical cause. I would not recommend that those subspecies be mixed. Regarding Sumatran rhinos, as another example, I am not aware of any evidence relating to possible divergence among the island populations, but the difficulty for a rhino in swimming long distances across strong currents makes such differentiation possible. It should be investigated.

You recently asked what is the cost to keeping possibly divergent populations separate in captive breeding programs? If we kept no more animals in the meta-population than would be kept in a single breeding program (so we don't waste conservation resources), and if we could carefully monitor the fitness of each population, so that corrective action (perhaps the fusion of the gene pools) could be taken if fitness began to decline due to genetic impoverishment of one or more subpopulations, there might be no cost. In fact, genetic variation can be retained better (though not with the same distribution of genes and gene combinations) in such a subdivided population if each population is independently maintained at a constant population size.

The caveats above are not inconsequential, nor easy to meet. First, if any subpopulation goes extinct, or even fluctuates much more widely in relative size than would a larger, panmictic population, then the outcome is decidedly worse than maintaining a single population from the start. (If half of a panmictic population dies from an epidemic, say, only a trivial amount of genetic variation is lost. If one of two isolated populations dies out, a great deal of genetic variation is lost.) To avoid possible genetic and demographic problems, there will be a strong tendency to keep more animals than would be necessary for a panmictic stock. I worry that this could easily happen with black rhinos.

Accurate monitoring of fitness deterioration that could occur because of over-fragmentation of a population will be extremely difficult and probably impossible in captive stocks. To give just one example from my own institution, the conventional wisdom around here had been that the increasingly inbred addax herd was doing just fine. Simple statistical analyses, however, showed that juvenile mortality has climbed from virtually zero to about 50%! The same trend can be seen in many species both here at Brookfield and in the breeding records of other zoos. Given the small sample sizes available, and the inevitable confounding by changes in husbandry, it is extremely unlikely that a loss of just 10% fitness could be detected in a breeding program. Yet that loss of fitness would be substantial for a wild population (or reintroduced animals), and could well prevent its survival. Moreover, juvenile mortality is just one component of fitness likely to be affected by inbreeding: fertility, disease resistance, and growth and robustness are all affected as well.

The effects of inbreeding have almost always been measured on captive populations that live in incredibly benevolent environs. Inbreeding seems to affect resistance to disease and other stresses perhaps more than it affects other traits. Do we want to risk losing disease resistance in our captive stocks that we are protecting for eventual return to the wild? Many SSPs are considering setting genetic goals for subpopulations as low as 80% or 85% retention of gene diversity. While some populations may have tolerated considerably greater losses, I would point out that for some species, a 20% decrease in variation (i.e., inbreeding coefficient of .20) causes almost 100% mortality even in zoos. The median effect of this amount of genetic loss obtained from the data in the Ralls et al. paper on 40 mammalian species is a striking 27% decline in juvenile survival (and unmeasured effects on other traits). I think that we need to be very careful not to let concern for possible, but virtually undemonstrated and likely very weak, local adaptation and outbreeding depression dominate our conservation programs to the point that we take insufficient care to prevent well demonstrated and almost universally damaging effects of inbreeding and losses of genetic variation.

I have no disagreement with those who claim that conservation efforts should aim for the retention of the full range of locally adapted and divergent wildlife populations. But such a goal cannot be met with captive populations; it can only be reached by protection of natural habitats, populations, and evolutionary processes. We simply cannot capture all the diversity of nature, with all the processes that created and maintain that diversity, in zoos. I get especially concerned when I hear people advocating the preservation in zoos patterns of variation that most likely arose only recently, because of drastic modification of habitats and wildlife populations by humans.

Some people have argued for what is essentially a geopolitical species concept -- saying that we cannot tell governments and peoples that their population of a species is not uniquely valuable, lest they fail to protect their biotic heritage. I too would argue that we should proclaim loudly the value of the populations of rhinos and other wildlife within each geopolitical unit, but I would argue that the values of the local wildlife populations are primarily ecological, economic, and aesthetic, not genetic. I think that the message we need to give to the peoples of the world is that zoos can preserve many species, maintaining gene pools that are rough approximations to what existed in the wild. We will endeavor to keep those captive gene pools sufficiently healthy so that they could be returned to wild environments where they could once again evolve as members of ecological communities. We cannot, however, be the keepers of all the magnificent diversity that occurs within each species (nor, of course, the keepers of ecological processes and evolving systems).

Local adaptive variations should be conserved in those habitats in which the adaptations evolved. When the option of captive breeding is chosen as an emergency measure for protecting any gene pool that has temporarily (we hope) lost its wild habitat, there should be an evaluation of the evolutionary distinctiveness of the gene pool to be preserved, relative to the distinctiveness of the many other taxa competing for such resource-intensive management. Irreplaceable genera will go extinct for lack of attention and resources devoted to their conservation. We need to be careful not to displace even more taxa from captive habitat in order to coddle marginally divergent local populations of more favored species.

Finally, I think that the economics of conservation will have to dominate discussions of subspecies issues. If zoos want 1,000 black rhinos for display and public education, then why not keep multiple forms? (Although, we may still, after considerable deliberation, decide that a panmictic population of that size is preferable to smaller, but still quite healthy, subpopulations.) If some billionaire who wants his own "unique" rhino stock wants to pay for the propagation of a particular local variant (and won't let his money be used more wisely), then let him go ahead. We should be wary, however, of possibly advocating unwise allocations of scarce conservation dollars that could better be turned to other purposes. We don't live in the best of all possible worlds and the choices we make among competing interests will be difficult. Triage will be necessary, especially in choosing taxa for protection in captive breeding programs.

I hope that some of this discussion is useful to you and to the rhinos.

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Dr Tom Foose,
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12101 Johnny Cake Ridge Road,
Apple Valley, MN 55124,
U. S. A.

27th April, 1992

Dear Tom,

I have looked over the black rhino material you recently sent me and have formed some opinions about the subspecies question.

In essence, I see two important questions here. The first is whether East and South African rhinos can be differentiated. The second question depends on a positive answer to the first, and asks if the two populations are distinct, how significant is the level of distinction relative to that seen in similar species, and do small genetic distances necessarily mean breeding problems are unlikely in captivity? In a world with unlimited resources, and given sizeable populations of East and South African rhinos, a positive answer to the first question would be enough to justify separate conservation of the subspecies. But in the real world this needs to be weighed against the effort required for separate subspecies conservation and the probability that such plans would succeed.

With regard to the first question, I do think the Ashley et al. mtDNA restriction site analysis does show differences at least between one individual in East Africa and two in South Africa. The sample size in this study is not large enough for definitive conclusions. George Amato seems to have a larger sample and I would find D-loop sequence evidence more convincing. Nuclear evidence of differentiation is also essential and the allozyme study of Merlander et al. did not sample the South African population. Just because there is low allozyme variability in the East African population does not mean it may not be distinct from the South African black rhino. Steve O'Brien's cheetah work showed that even in the absence of allozyme variability within a population, fixed differences existed between East and South African cheetahs.

If we assume some measure of distinction, albeit small, how relevant is this information for captive breeding programs? I disagree with the firmness of the conclusions of Ashley et al. that small distances mean interbreeding is okay. One hundred-thousand years is still a long time, the long generation time of rhinos is balanced against their small population size such that considerable adaptive evolution may have taken place. We do not know whether important adaptations and phenotypic distinction will be lost or, more importantly, reproductive problems might develop. We know painfully little about the relationship between genetic distance and fitness, and one could hardly make generalizations about reproductive compatability from distance data. Essential for interbreeding considerations is better data on chromosomal differences. Ollie's graph about differences in chromosome number is intriguing and I think interbreeding plans might hinge on this data. Is there more complete data now available? (The data of the graph is July 9!)

I think it needs to be demonstrated that the two subspecies have not now, or in the recent past, exchanged genes. If they have this is good evidence that the two species can interbreed and no need is required for separate conservation programs. A genetic analysis of many more individuals from East and South African populations is required to determine the degree of genetic exhange.

I would like to see D-loop sequencing done on a population sample of both subspecies. Using PCR, very small samples are required. Potentially, even museum material may be used. Better nuclear gene characterization is also desirable and VNTR analysis, especially utilizing microsatellite loci is a good candidate. Microsatellite analysis involves the use of PCR so museum material can be utilized. Moreover, it is a single-locus approach which makes it more desirable than a multilocus RAPD analysis.

Finally, the chromosome analysis needs to be completed. How related are the captive Kenyan rhinos that show reduced chromosome arm number? Much needs to be discussed with regard to the chromosome data.

Good luck!

Yours sincerely,

Robert K. Wayne, Ph.D.
Head of Conservation Genetics

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Monday, April 27, 1992

Thomas J. Foose
Captive Breeding Specialist Group
12101 Johnny Cake Ridge Road
Apple Valley, MN 55124

RE: Is it appropriate to conserve *D. b. michaeli* and *D. b. minor* as separate populations?

Dear Tom,

Considerations:

Given the effort invested in the examination of genetic differentiation of other taxa and the resultant data sets that have been produced (e.g. *Drosophila sp.* , *Macaca sp.*, *Peromyscus sp.*), the small amount of data currently available for consideration of this issue in *Diceros bicornis* is noteworthy. The limited nature of the data should be recognized.

It appears there are no relevant allozyme data.

Although RAPD is a powerful technique of potential importance, we have as yet no quantitative data from RAPD analyses. It is important to note that few comparative data from other taxa utilizing RAPDs are yet available.

RFLP of mitochondrial DNA identifies diagnostic differences between *D. b. michaeli* and *D. b. minor*. However, these differences are of a small magnitude (0.29% (Amato, et al.)). This finding is substantiated by the results of two separate investigations (Ashley, et al. and Harley and O'Ryan).

Limited chromosomal DNA is available from rhinos. The value of collecting such data has been recognized in previous investigations (e.g. Ashley, et al.; Amato, et al.). Chromosomal arm number might be the most highly variable genetic parameter in black rhinos yet investigated. Sample size in these studies is sufficient for *D. b. michaeli* but limited for *D. b. minor*. Findings of intra-specific chromosomal structural variation suggestive of population substructure have been noted that are consistent with the geographical partitioning noted for mitochondrial DNA RFLPs. However, the karyotypic data derive only from comparison of animals from Zimbabwe with those from animals throughout Kenya. Chromosomal examination from other populations has not been reported. Additional chromosomal data from black rhinos in Zimbabwe and Kenya and new data from South Africa and Namibia would be useful.

Findings of discontinuities in gene flow across a species' range that produce evidence of population substructure, partial or complete isolation suggest caution or restraint in the merger of populations when conservation of naturally genotypes is a goal.

The discussions concerning the appropriateness of separately conserving *D. b. michaeli* and *D. b. minor* populations should take place in the context of clearly defined goals which may not yet have been fully elaborated. Each of the two named subspecies has sufficient numbers to support separate conservation efforts *in situ* in accordance with the geographical distribution of populations across the species range. Is there a necessity to contemplate interbreeding individuals of the two geographical populations for *in situ* management? Does the discussion of population merger apply only to *ex situ* conservation efforts?

Geographic separation of populations is a strong factor in consideration of separate conservation efforts (Dizon et al., Conservation Biology 6:24-36, 1992). Other ungulate species show differentiation between East and South Africa. In addition to genetic factors, other aspects such as zoogeography, natural history, ecology, and differentiation of associated faunas should be considered. This notion was part of the original concept calling for the identification of concordant data sets in the analysis and designation of evolutionary significant units.

Conclusions:

In situ efforts are organized into geographical and political units that tend to reinforce the management of separate populations of *D. b. minor* and *D. b. michaeli*. These efforts come as close as is possible to the conservation of naturally structured populations. Based on all the available genetic data, the northern (Kenya) and southern (Zimbabwe and South Africa) populations of black rhino are probably genetically distinguishable. However, the extent of differentiation is small. The ecological and evolutionary significance of these differences is not clear. There probably is some geographic substructuring surviving within the formerly extensive distribution of *Diceros bicornis*. The likelihood that reduced fitness would result among individuals of mixed subspecies ancestry is considered small, but this notion has not been tested. Although the available genetic findings do not clearly mandate separation of the subspecies in *ex situ* conservation programs, this does not constitute a recommendation that they be merged. In fact, other considerations such as the relevance of *ex situ* populations for reinforcing wild populations may appropriately be considered. A perception of limited genetic differentiation is insufficient as a single criterion for, in effect, restructuring gene flow among populations lying at the opposite ends of an extremely large species range. Current management of Eastern and Southern forms is probably appropriate.

Best wishes,

Ollie

Oliver A. Ryder, Ph.D.

Subspecies and Black Rhinos

George Amato
New York Zoological Society

It is clear to most of us involved in the conservation of endangered species that accurately identifying our units of conservation is the foundation to a sound conservation strategy. By conserving the patterns of naturally occurring biodiversity, we can increase our chances of maintaining healthy populations *in situ* and *ex situ*.

In the past, subspecies concepts were approached from two distinct disciplines--taxonomy on the one hand and population genetics theory on the other. Only in recent years have investigators looked for the interface of these two (e.g. John Avise's concept of phylogeography). The approach we have been using in our research has been to apply an operational evolutionary species concept to a lower level systematics analysis of character data. In this manner we are attempting to identify patterns representing evolutionary events in order to identify Evolutionarily Significant Units. These E.S.U.s would be our units of conservation. At the same time we are comparing our data sets, as well as those from other labs to determine if we can generalize an approach to future questions.

The subspecies status of *Diceros bicornis* first came to my attention three years ago when I came to work at NYZS. At that time, I met Mary Ashley who had just completed her mitochondrial DNA RFLP study in Don Melnick's lab. Along with some other projects, I began a preliminary survey of allozymes on the same samples that Mary had used in her study. I first surveyed for two systems that Adina Merenlender had found variable in her study of captive rhinos. I detected very little variation in the samples and decided to reexamine the past data as well as what might be a better approach to this question.

In reviewing the morphological data, it appears to support a cline in size across the range, with a great deal of overlap and little support for subspecific designations. The faster evolving mitochondrial genome of these animals was a sensible place to look for population subdivision. However, even data from this region did not support meaningful differences between populations and was consistent with the morphological data of a cline. Allozymes, which are typically uninformative for systematics, appeared less likely to show population subdivision unless you conducted a very large survey in an attempt to show that some polymorphic loci were out of Hardy-Weinberg equilibrium and were evidence for assortative mating (a difficult approach to do on small scattered populations of black rhinos). This led to our decision to concentrate our efforts (at least as far as rhinos are concerned) on the Sumatran rhinoceros, where there was good justification, from the animals disjunct distribution, for concerns about subspecific status. Since that time we have continued to generate DNA sequence data and RAPD profiles on black rhinos in order to have a complete picture of the molecular evolution of *Rhinocerotidae.* In contrast to our work on Sumatran rhinos, we have not found characters to justify a division within black rhinos.

We know that we can find variation down to the level of the individual. However, that is not the point of our research. We will continue to use sequence data as characters, since this has been demonstrated to be a powerful systematics approach. At the same time it is important to examine examine cytogenetic data, and we greatly encourage cytogenetics labs to examine the same materials whenever possible. The great difficulty, of course, is that the material suitable for cytogenetics investigation is only a tiny fraction available for a DNA sequence analysis.

60 06324053

Dr. George Amato,
Conservation Geneticist,
New York Zoological Society,
Bronx, New York 10460.
U.S.A.

ZOO MELAKA 63/4(02)

JANUARY 6, 1992

Dear Dr. Amato,

I hope you have received the letter that I sent earlier last year requesting for the protocol for the buffer that you described in your letter dated July 25, 1991. I have yet to receive the protocol.

I will start collecting some samples from both species before end of the month. I would appreciate if you could be more specific as to the type of water required for mixing with the ingredients. Is there any concern for pH ?

It would be good if you could fax me with information regarding the buffer. My fax number is 06 - 325 - 869.

Sincerely,

Zeinal Zahari Zainuddin
Veterinarian, DWNP,
Zoo Melaka, Air Keroh,
75450 MELAKA

cc: Mr. Mohd Khan bin Momin Khan
Director General, Dept. Wildlife
and National Parks, West Malaysia.

60 3 905 2873
60 3 25

NEW YORK ZOOLOGICAL SOCIETY

January 17, 1992

Dr. Zainal Zahari Zainuddin
Veterinarian, DWNP
Zoo Melaka, Air Keroh
75450 MELAKA

Dear Dr. Zainal:

I apologize for not answering your FAX immediately, but I was attending a DNA fingerprinting conference and did not receive it until today.

I hope you have received the buffer ingredients and protocol that I sent to Dr. Mohd Kahn. Now that I have your address I can send anything additional directly to you. Also, I know that sometimes there is a problem with our mail system getting packages over seas.

The buffer is 100 mM Tris, 100 mM EDTA, and 2% SDS in water. When this buffer is mixed 1:1 with blood, the sample is stable at room temperature, indefinitely. The pH is not important. The protocol was developed by scientists working on field studies. They mixed the dry reagents with water from a mountain stream. The 2% SDS will lyse any cells, so there is no concern with bacterial contamination. Certainly, any water suitable for drinking would be fine. I sent the dry reagents in tubes to be mixed with 1 liter of water (one tube of reagents per one liter of water). If you did not receive these (or if you need more) please FAX me and I will send it to you by express mail. The reagents can be stirred or shaken into solution. Of course, you should decide on how much blood is safe to draw. I can easily work with 5-10 mls mixed with an equal amount of buffer. However, even smaller samples (2 mls) would still be useful.

I will keep you appraised on all data generated and progress in this project. All publications dealing with these samples will be coauthored with yourself and appropriate colleagues. I have sent you a copy of the paper I wrote for the rhino conference in San Diego. It was there that I had an opportunity to meet Dr. Mohd Kahn who was very helpful and encouraging.

I hope we have an opportunity to meet in the future, and perhaps work together in the lab, here or in Malaysia.

Thank you and Dr. Mohd Kahn for all your help. I can assure you that the Sumatran rhino project is our highest priority.

Sincerely,

George D. Amato

George Amato
Conservation Geneticist
New York Zoological Society

cc: Dr. Mohd Kahn bin Momin Khan

Sumatran rhino sampling for determination of subspecific status.

1. Hair samples can be used for isolating small quantities of DNA. These samples can be used for sequence analysis of specific genes with direct sequencing of PCR (polymerase chain reaction) amplified regions. In addition, RAPD (randomly amplified polymorphic DNA) markers can be identified from some of these samples (as presented at the San Diego Rhino Conference). For these reasons, hair samples should be saved. They can be kept dry, at room temperature, in small plastic bags. They can later be sent at a convenient time without special conditions or preparations.

2. Blood samples are of even greater value. Whole blood or spun cells can be stored and shipped under a variety of conditions.

A. Five or ten mls of whole blood can be drawn--then stored and shipped frozen.

B. Five or ten mls of whole blood can be mixed with an equal volume of RT buffer (100mM Tris, 100 mM EDTA, 2% SDS) and stored at room temperature. In the buffer the blood sample is stable indefinitely, and can be shipped without any special conditions.

C. Whole blood can be drawn into EDTA vacutainer tubes, and stored and shipped cool (not frozen) through express mail. These samples could be used for other analysis besides genetics (determining vitamin E levels etc.)

Any of these methods will provide sufficient material to look at mitochondrial RFLP's (restriction fragment length polymorphisms) and nuclear markers. These characters, along with the information available from the hair samples of animals from which we cannot draw blood, will provide us with the necessary information to form conclusions about the subspecific status of Sumatran rhinos.

Certainly, the easiest method is to use the room temperature (RT) buffer. I will send the reagents for this buffer through express mail (you will simply need to add water). If blood is collected before the buffer arrives, you can freeze it. It can later be thawed and mixed with the buffer. The sample will then be stable at room temperature for easy transport.

Any questions can be directed to me at FAX 203 432-3854 or FAX 212 220-7114

As I stated at the rhino meetings, we have given the Sumatran rhino subspecies question the highest priority and will continuously keep all involved up to date on data collection and analysis.

Thank you for all the help on your end. I look forward to communicating with you soon.

Sincerely,

G. Amato

George Amato
Conservation Geneticist
New York Zoological Society

American Association of Zoological Parks and Aquariums

◆ A nonprofit, tax-exempt organization dedicated to the advancement of zoological parks and aquariums for conservation, education, scientific studies and recreation ◆

Species Survival Plan

29 APRIL, 1992

TO: TOM FOOSE

FROM: KEVIN WILLIS AND BOB WIESE

RE: SUB-SPECIES OF BLACK RHINO

We have just read the letters from Ed Maruska, Gary McCracken, Bob Lacy, Russell Lande, and Joel Cracraft on the question of whether or not to interbreed the two named subspecies of black rhinos. We feel there is not much we can add to the scientific debate on subspecies as that issue was covered in detail by others. The truth in this case is not known, and so opinion must be formed from the available data. Obviously there are differing interpretations of the data analysis, and as always there is a call for further data collection. It is probably safe to say that this issue will remain controversial. The only way to conclusively prove that the two forms should not be interbred is to determine whether or not hybrids are sterile. However, there is no conclusive test which can be used to determine whether the two forms should be interbred. Even if the two subspecies were shown to interbreed without any detrimental effects, there would be those that would maintain that the forms had distinct evolutionary histories and should have been kept as distinct populations: one fixed difference is sufficient under the phylogenetic species concept to justify separate programs. Given that many species populations have been recently bottlenecked and fragmented, we feel that using an equilibrium model of speciation (i.e., a fixed difference between two populations makes them distinct evolutionary units <u>if and only if</u> an equilibrium between the evolutionary forces of genetic drift and gene flow has been attained) is unwarranted. However, there is no shortage of examples in the literature that one can use to support either opinion. The recent paper by Grant and Grant (SCIENCE 256:193-197) will certainly be used by "lumpers" as an example of the benefits of interbreeding different forms.

We think that applying the logic that was used in the paper on use of individuals of unknown ancestry in breeding programs is applicable to this situation as well. There are two possible truths: they are distinct forms that should not be interbred, or they are not distinct forms. And there are two possible decisions: interbreed them or don't interbreed them. There are then two ways to be correct and two ways to be incorrect. The decision should be influenced by the potential consequences of being incorrect.

If they are different forms and a decision is made to interbreed them, the potential consequence is outbreeding depression. Even with limited test crosses, in the short term this would be somewhat detrimental in terms of lost time and resources. However, if it was determined that hybrids were not fertile/viable, interbreeding could be suspended with no long term effects.

If they are not different forms and a decision is made to keep the two named forms separate, the effect will not be felt by the captive black rhino populations (both subspecies have, or will soon have ample founders), but it would impact another species that could have used the space and resources. The long term effect is that one less large mammalian species can be bred in our institutions (we think it very unlikely that the Rhino TAG would decide to only keep one of the subspecies in captivity given that D.b. minor is currently being imported).

In the short term, if there is any reason to think that further genetic analysis could resolve this issue, it would be better to not produce hybrids. At this stage in the breeding program there is no immediate need to start interbreeding as there are many pairings that will not produce inbred offspring. This issue will only become critical from the population manager's perspective when a decision has to be made on whether to inbreed or outbreed. In the long term we feel that the first error (incorrectly lumping) is preferable to the second (incorrectly splitting). The first can be reversed by stopping the production and reproduction of the hybrids. The second, once the decision is made, is likely to become permanent.

If the ultimate decision is arrived at for political rather than biological reasons, the above arguments are largely irrelevant. It is clear in this country that we are much more concerned about keeping the Florida panther than keeping panthers in Florida. The same is likely to be true with rhinos in Africa, especially if the commonly used names of the different forms were to become e.g., the Kenya rhino and the Zimbabwe rhino. There may be considerable political and popular pressure to have the forms be considered distinct on this basis alone.

In summary, we feel that this is somewhat of a no-win situation. A decision based on biology will more than likely lack any sort of definitiveness, and a decision based on politics may already have been made. Our opinion, which we arrived at based on the biological aspects of the problem alone, is that limited interbreeding be tried with one or two pair of over represented individuals at sometime in the future in order to determine the viability and fertility of hybrids before a decision has to be made on whether to inbreed or outbreed. We hope that our comments, which we tried to frame with a different perspective, will foster discussion.

KEVIN

Bob

cc. M. Hutchins, R. Reece, B. Read, S. Taylor, D. Meritt, B. Maruska

RHINO GLOBAL CAPTIVE ACTION PLAN WORKSHOP

BRIEFING BOOK

LONDON ZOOLOGICAL GARDENS
9-10 MAY 1992

SECTION 14

HUSBANDRY

MANAGEMENT PARAMETERS AFFECTING THE REPRODUCTIVE POTENTIAL OF CAPTIVE, FEMALE BLACK RHINOCEROS, *DICEROS BICORNIS*

Russell L. Smith and Bruce Read

San Antonio Zoological Gardens and Aquarium
Saint Louis Zoological Park,

Short Title: Female Rhino Reproduction

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Submitted to ZOO BIOLOGY

ABSTRACT

With deterioration of the wild population over the last two decades, captive reproduction of black rhinoceros has become a high priority for zoological gardens. Several reproductive parameters of female black rhinoceros were analyzed with data from the international studbook and compared to data from field studies. These analyses yielded comparisons for ages of females at first calving, length of birth intervals, and span of reproductive life. The implications for rhino productivity are discussed and some suggestions for increasing productivity are presented.

Key words: birth interval, captive breeding, Species Survival Plan, birth rate, natality

INTRODUCTION

With the decline of the wild population of black rhinoceros, Diceros bicornis, from an estimated 60,000 animals in 1970 to less than 4,000 today, the zoological community has placed more emphasis on the establishment of a self sustaining captive population [du Toit, 1987]. Such a population will have to be able to not only sustain its current numbers but to grow to the designated carrying capacity without supplement of animals from the wild [Conway, 1980; Seal, 1986; Soule' and Wilcox, 1980]. (The Black Rhinoceros Species Survival Plan of the American Association of Zoological Parks and Aquariums has proposed a carrying capacity of 150 animals, for North America [Maruska,1987]. The estimated world, captive carrying capacity is 200 - 250 black rhinos [Cumming, 1987]). The establishment of a self sustaining population requires that it be capable of reaching the carrying capacity with the desired genetic representation. The population then needs to be stabilized with regard to founder representation, sex ratios, and age distribution. [Foose,1980] To accomplish this, the captive management of the black rhino should be analyzed to determine what factors affect population growth.

Unfortunately, the captive population for black rhinos has not been able to sustain itself without recruitment from the wild. As many as half of the captive animals have never reproduced, and birth rates approximately equal death rates [Lacy, 1987]. The studbook keepers, Klos and Frese, have criticized the declining captive population for years [1983, 1987]. "The average birth rate of six individuals is opposed by a death rate of nine annually [Klos and Frese, 1987]". Although medical and nutritional problems exist [Jones, 1979; Miller and Boever, 1982; Ott, et al, 1982; Dierenfeld, et al, 1988; Miller, et al, 1990], those problems do not seem to have directly affected reproduction. The authors will address a less publicized problem, breeding management. In addition to the demographic problems inherent with a low birth rate, genetic diversity can be lost. In general, the faster the growth to carrying capacity, the less genetic diversity is lost [Foose, 1987].

Three basic factors characterize the reproductive performance of the female black rhinoceros: the age when she produces her first calf, the intervals between births, and the span of her reproductive life. Once these have been determined, the manager can build a breeding program which attempts to achieve the maximum production from each female in the population. By comparing what has been observed in the wild and in captivity, a manager can determine if captive breeding and breeding in the wild are equally productive. If not, a review of data may indicate how captive reproduction may be improved.

METHODS

Reproductive data on 68 female black rhinos, that have reproduced in captivity, were obtained from the International Studbook of the Black Rhinoceros and the International Studbook of African Rhinoceros [Klos and Frese, 1981,1983,1987]. These data yield information on the age at which females produced their first calf (Table 1), the length of birth intervals (Fig. 1), and the span of reproductive life.

RESULTS

In order to eliminate the estimated ages of wild caught, captive animals, we looked at the age at first parturition for captive born female black rhinos. The average age at which a captive-born female (N-17) produces her first calf is 9 years (Table 1). This is late compared to data from the wild where the average age at first parturition in wild females was determined to be: 4.75 - 5.25 years [Schenkel and Schenkel-Hulliger,1969], 6.25 years [Hall-Martin, 1986], and 6.5 and 8.5 [Hitchens and Anderson, 1983]. A survey of captive females yielded an average estimated age at sexual maturity of 5.25 years (range 3 - 10 years) [Maruska et al, 1986], which is closer to estimates from the field. Age of sexual maturity for females in the wild was determined to be: 3.5 - 4 years [Schenkel and Schenkel-Hulliger, 1969], 3.8 years [Hall-Martin, 1986], and 7 - 8 years [Hitchens and Anderson, 1983].

The average of 91 captive birth intervals is 38 months (Fig. 1), as compared to averages of: 26 months [Joubert and Eloff, 1971], 27 months [Goddard, 1967], 32 months [Hall-Martin, 1986], and 30 - 39 months [Schenkel and Schenkel-Hulliger,1969] for birth intervals in the wild. However, 18 (20%) of the captive birth intervals were 24 months or less (Fig. 1), with the shortest interval being 16 months. The shortest recorded birth intervals from wild females are: 24 [Hall-Martin, 1986], 25 [Goddard, 1967], and 26 months [Jombert and Eloff, 1971].

Schenkel and Schenkel-Hulliger [1969] estimated that a wild female black rhino produces at least 7 and at most 12 calves over a reproductive life span that ends between 30 and 35 years of age. Owen-Smith [1988] estimated a life span of 40 years, with a maximum of 18 and a mean of 14 calves produced. Longevity into the thirties and sometimes forties is not unknown in captivity, with one female living to be 48 years old. However, females in captivity have demonstrated a shorter reproductive life than has been cited for wild females. The studbook keeper, Klos, has noted that breeding ceases at about

20 to 25 years [Klos and Frese, 1987]. No female has produced a calf in captivity after her 24th year, although eighteen previously reproducing females have lived or are living past that age. The earliest a female of known age has produced a calf is 6.5 years (Table 1). The reproductive life of a captive, female black rhino as determined by the data is from her 6th to her 24th year.

Recruitment due to natality has been demonstrated to be better in wild than in captive black rhinos [Table 2]. The birth rate of captive black rhinos from 1980 until 1986 is an average 4.1% per year. Birth rates in some wild populations have been demonstrated to be: 7.0% and 7.2% [Goddard, 1967], 9.0% and 9.6% [Hall-Martin, 1986], and 5.3% and 11.0% [Hitchens and Anderson, 1983].

DISCUSSION

By building a management program based on a female's first parturition at six years of age and birth intervals of two years, the lifetime reproductive potential of captive females could parallel the estimated production of wild females. Since most captive female black rhinos have failed to reach this level of reproduction, the question of how current management practices affect the reproductive potential of black rhinos must be addressed. Most captive females have not reached the end of their reproductive lives. For purposes of comparison and as a reproductive goal, we will consider that the production of ten calves over a female's reproductive life to be her optimal production. An evaluation of reproductive production can be made by comparing age of reproducing females and the number of calves produced against the hypothetical optimal production. Most captive females fall short of the optimum (Fig.2), but several females in different institutions located on different continents have come close. This does beg the question: is our hypothetical optimal production possible? A seven year old, studbook #284, with her first calf and a fifteen year old, studbook #213, kept up with the hypothetical optimal production (Fig. 2). Since the last issue of the studbook was published, #213 has continued her optimal production, with eight calves born to date, her ninth calf is due August, 1991 [M. Sulak, personal communication].

With this information in mind, managers should determine if their management of the animals is consistent with their reproductive goals. If the goal is to achieve rapid increase in the captive population to reach the carrying capacity set for the population, then animals should be manipulated to achieve maximum reproduction. Once this has been accomplished, the management strategy can be adjusted to maintain the desired rate of reproduction.

There is no doubt that the introductions of reproductively mature rhinos has produced anxiety for the managers of those animals. Although wild rhinos are not aggressive during pre-copulatory behavior [Goddard, 1966], captive animals have shown aggressive behaviors during introductions. It seems probable that the failure to introduce animals or the termination of introductions to reduce the possibility of injuries has impeded reproduction. Jones [1979] suggests that introductions be made while the animals are separated by bars or a fence. He also suggests giving the animals as much room as possible to allow for chasing and mock fighting. As with any other captive wildlife, there is no substitute for the manager's knowledge of the individual animals involved and thoughtful, deliberate decisions.

Some suggestions for achieving a desirable rate of reproduction are:

1. Move female calves approaching three years of age into situations where they can be bred, preferably with a proven breeding male. This would insure that young females are bred as early as possible, thus entering into the reproducing population earlier. Species, such as rhinos, with a prolonged pre-reproductive period suffer a dramatic reduction of reproductive potential if the age at first parturition is increased [Cole,1954]. Conversely, a shorter pre-reproductive period can significantly increase the reproductive rate.

2. Make a concerted effort to keep birth intervals as close to two years as possible. This will involve reintroducing the breeding pairs, earlier than is commonly done. Three strategies for early reintroduction are outlined here. At the St. Louis Zoological Park, calves are weaned at about six months of age. This has been done gradually to reduce stress. A calf born 6 November 1986 was separated from its dam and kept in a stall for one hour per day starting the first week of May 1987. During the second week of May, the time of separation was extended to two hours for three days and then extended to the entire morning. During the third week of May, the calf was separated from its dam from morning until 4:00 pm. This was continued until the staff was satisfied that the calf

was eating well on its own. Complete separation took place on 19 June. The calf was then familiarized with a shipping crate and was sent to another zoo on 14 July. The female was introduced to a male, who shared two pens with her twenty four hours a day. The female was bred back on 22 July, 258 days after giving birth. At the San Antonio Zoological Gardens and Aquarium, calves became accustomed to being separated from the dam, for about one hour, while the pen was being cleaned. This was started at three to four months of age. Calves may temporarily exhibit weaning distress but no calf has injured itself. When the male begins to show interest in the cow, the calf can be separated while the male and female are introduced. This routine can be continued for as long as the male exhibits interest in the female (standing by the gate of the female's enclosure, vocalizing, penile erection, etc.). Calves have been totally separated from the dam at about one year of age. Mating has occurred on this schedule as early as 107 and 116 days post partum. At the San Francisco Zoological Gardens, a very trustworthy male was separated from the female immediately prior to parturition and reintroduced to the female and calf six weeks post-partum. These rhinos are kept in separate stalls at night but share a yard during the day. The seven birth intervals for this female average 24 months.

CONCLUSIONS

Simple management decisions have long-term effects on captive populations. More intensive management has been proven to increase production, especially in mammals with lengthy gestation and birth intervals (Read, 1986). By comparing the data from captivity with the data from the field, we can partially evaluate current captive management. If the goal of expanding the captive population of black rhinos is going to be reached as rapidly as possible, current management strategies need to be improved. Managers need to manipulate the population to achieve the maximum reproduction of females.

ACKNOWLEDGEMENTS

The authors wish to thank the directors and various staff members of their respective institutions for support, comments, and assistance. The international studbook keepers not only regularily published pedigree and demographic data, but were among the first to emphasize management in their studbook.

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TABLE 1

AGE AT FIRST PARTURITION OF KNOWN AGE, CAPTIVE BORN FEMALES

Studbook Number	Birthdate	Date of first calf	Age at First Parturition
6	10 Dec.58	11 Nov.69	10.9
29	Aug.60	9 Jul.69	8.9
55	27 Jul.61	1 May 68	7.8
101	2 May 65	20 May 75	10.1
119	22 Mar.62	23 Apr.73	11.1
126	20 Jan.68	7 Nov.78	10.8
139	20 Feb.70	4 Jan.78	7.8
150	27 Aug.70	18 Sep.78	8.1
163	6 Jan.71	25 Aug.77	7.7
165	20 Oct.71	3 Feb.80	8.3
160	21 Mar.70	3 Nov.77	7.6
183	1 Feb.72	21 Jul.83	11.5
190	26 Nov.69	29 Mar.79	9.3
212	9 Nov.75	6 Nov.86	11.0
267	16 Sep.76	25 Aug.85	8.9
270	25 Jul.78	21 Oct.85	7.3
284	12 Sep.79	3 Mar.86	6.5

average for 17 females = 9.0 years

AUTHOR/LOCATION	SEXUAL MATURITY (y)		AGE FIRST CALVING (y)		BIRTH INTERVALS (m)		BIRTH RATE
	Min.	Mean	Min.	Mean	Min.	Mean	Calves/Population/Year
Goddard, 1967							
Ngorongoro,Tanzania					25	27	7.0%
Olduvai Gorge, Tanzania							7.2%
Schenkel & Schenkel-Hulliger, 1969							
East Africa		3.5–4		4.75 5.25		30· 39	
Joubert & Eloff, 1971							
Namibia					26		
Hitchens & Anderson, 1983							
Hluhluwe, R. So. Africa		7–8		12		32	5.3%
Umfolozi/Corridor, R.So. Africa			6.5	7.5		28	11%
Hall-Martin, 1986							
Addo, R. So. Africa	3.8		5.1	6.25	24	32	9.6%
Kruger, R. So. Africa							9.0%
Owen-Smith, 1988							
(Review)		6				30	
Captivity, 1980–1986	3	5.25	6.5	9	16	38	4.1%

Table 2. A comparison of some reproductive parameters of black rhinoceros (y = years; m = months)

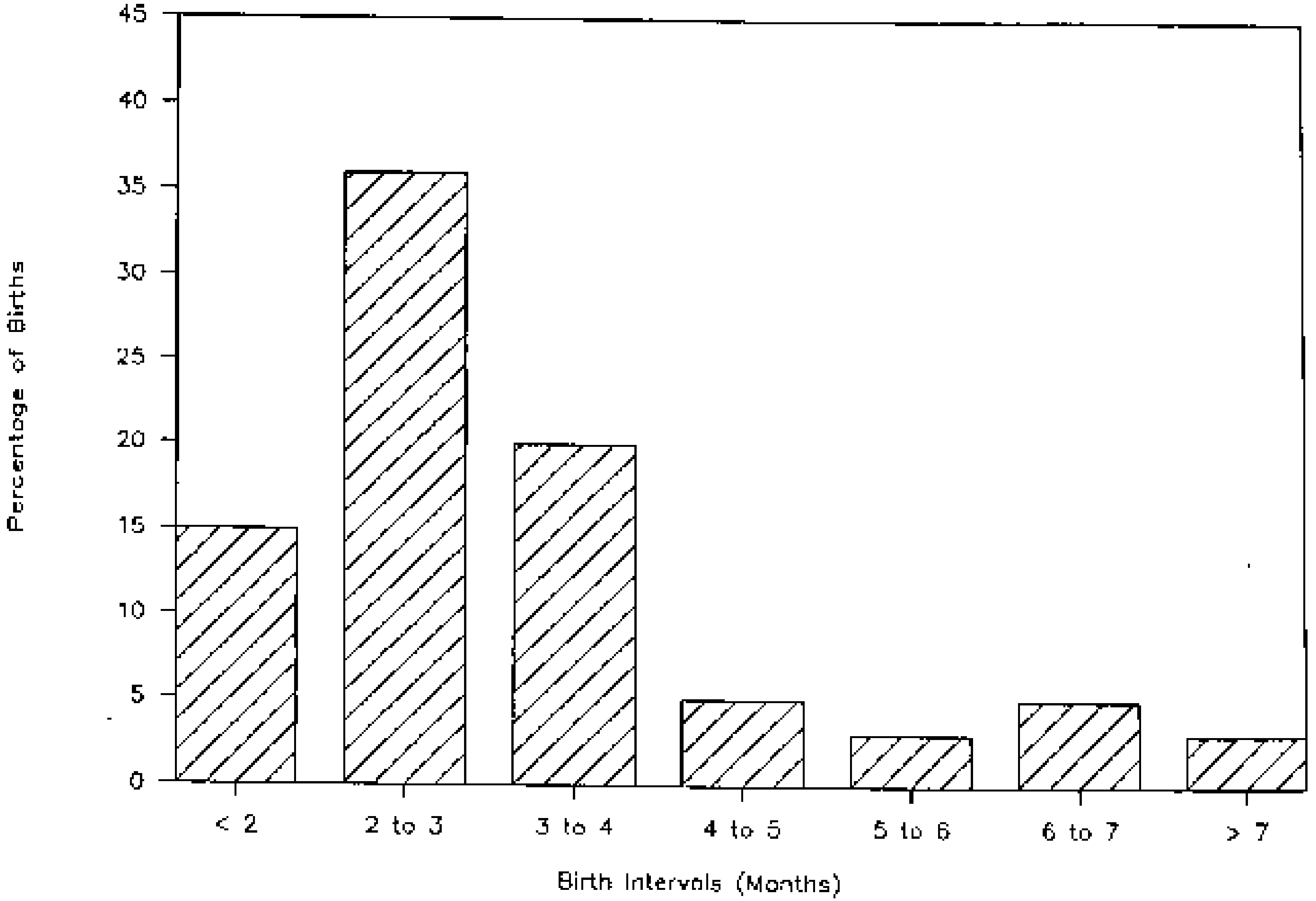

Fig. 1. Distribution of individual birth intervals for female black rhinoceros in captivity.

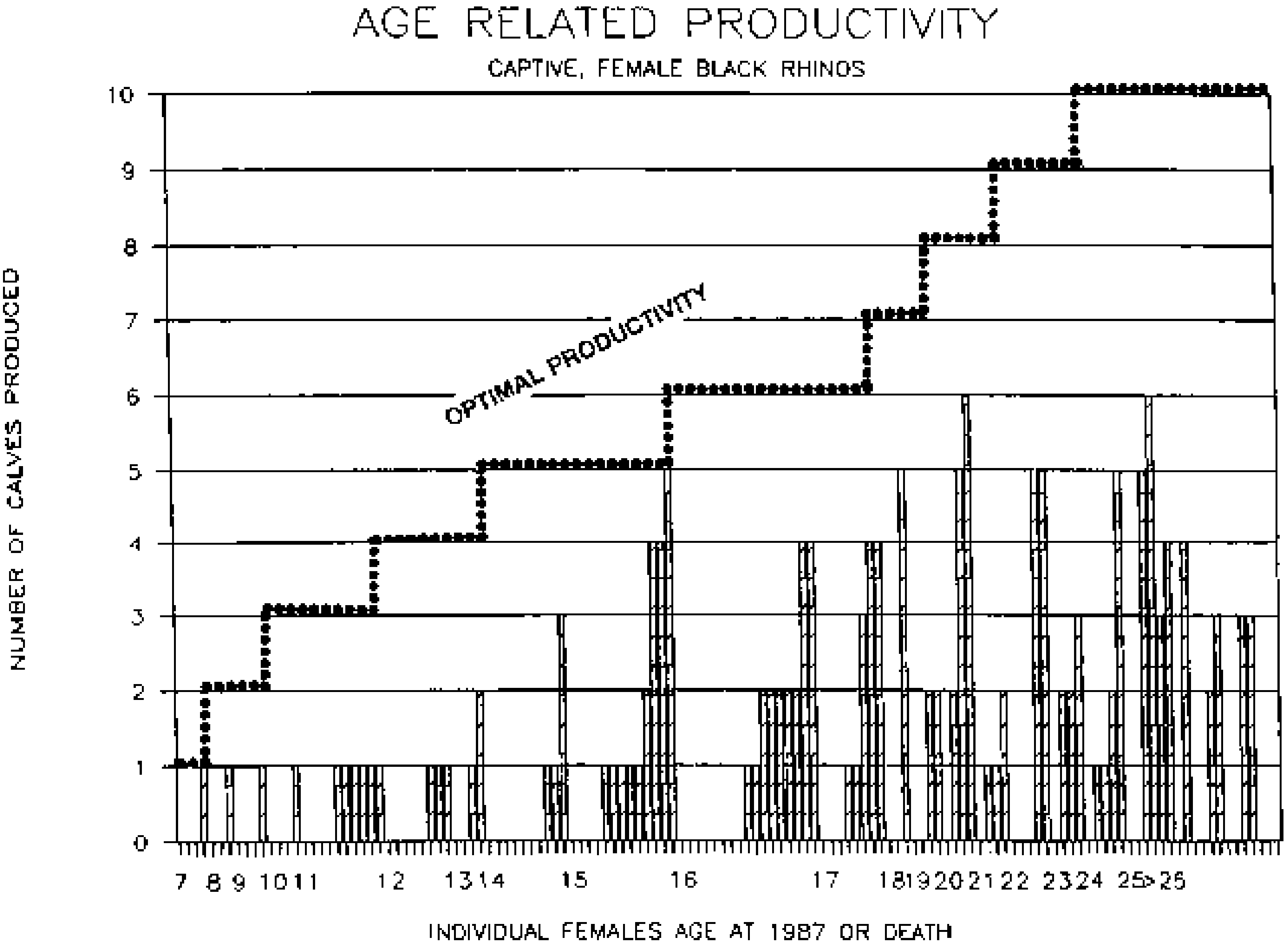

FIG. 2. Age related productivity of individual females. Each line represents a female registered in the international studbook from its inception. Productivity of reproducing females (N = 68) represented by black bar. Non-reproducing females (N = 65) have no bar.

5 July 1991

Comparison of data:	from 1987 studbook		from 1991 studbook	
Age, captive born female produces 1st calf, Min.	6.5		8.5	
Mean	9 (rounded off)		8.8	
	(N = 17)		(N = 22)	
Oldest dam	14 years old		26 years old	
	(stb#37,55,121)		(stb.#18)	
	26 years old[whoops]		28 years old	
	(stb.# 100)		(stb.# 55,185)	
Average birth interval rounded off	38 months		40 months	
	(N = 91)		(N = 121)	
Distribution of birth intervals:				
Fig. 1. 1 - 2 yrs	15	17%	25	21%
2 3	36	41	45	37
3 - 4	20	23	23	19
4 - 5	5	6	10	8
5 - 6	3	3	4	3
6 - 7	5	8	9	7
>7	3	3	6	5
females 7 yrs +				
reproduced	68		83	
never reproduced	65		71	
fig.2. females that achieved 'maximum productivity'	one 7 yr.old		four? 7 yr.old (new captures)	
	one 15 yr.old		one 8 yr.old one 19 yr.old	

NEW YORK ZOOLOGICAL SOCIETY

Ed Maruska, Director
Cincinnati Zoo & Botanical Garden
3400 Vine St.
Cincinnati, OH 45220

12 September 1991

Dear Ed,

Unfortunately, I will not be attending the AAZPA meeting this year, but enclosed is a brief report on nutritional studies activities for black rhinos over the past year.

Also, for your information only (not for distribution), I am sending a copy of a draft manuscript in preparation entitled "Nutrient Composition of Selected Browses Consumed by Black Rhinoceros (Diceros bicornis) in Zimbabwe and Texas" which includes interesting information on proximate composition, available protein, minerals and vitamin E levels quantified in numerous browses eaten by black rhinos. I am awaiting input from co-authors Raoul duToit and Lee Bass; I believe we'll submit this to J. Zool. (London).

Please feel free to contact me with any questions.

Sincerely,

Ellen

Ellen S. Dierenfeld, PhD
Nutrition Advisor

cc: (report only)
B. Dresser
R. Reece
U. Seal
T. Foose

BRONX, NEW YORK 10460 TELEPHONE 212-220-5100 TELEX [illegible]

NEW YORK ZOOLOGICAL PARK (BRONX ZOO) • NEW YORK AQUARIUM • WILDLIFE CONSERVATION INTERNATIONAL
CENTRAL PARK ZOO • OSBORN LABORATORIES OF MARINE SCIENCES • ST. CATHERINES WILDLIFE SURVIVAL CENTER

Conservation Education Research

BLACK RHINOCEROS NUTRITION RESEARCH UPDATE

1991

Ellen S. Dierenfeld, PhD
Nutrition Advisor
Black Rhinoceros (<u>Diceros bicornis</u>) SSP Committee
Rhinoceros Taxon Advisory Group

Vitamin E studies continue as a primary research focus in rhinoceros species, with blood and/or tissue samples analyzed from 9 institutions (including Leipzig, Germany) over the past year. Two commercial vitamin E supplements with enhanced absorption capability at the gut level (Tocopherol Polyethylene Glycol Succinate [TPGS], Eastman Chemical, Inc. and Em-Celle, Stuart Products, Inc.) are currently being fed to black rhinos. Both preparations have been shown to increase circulating plasma levels of α-tocopherol rapidly; studies are underway to determine optimum dosages. Basic physiological/biochemical studies with both black and white rhinoceros are in progress or planned for the upcoming year. This report summarizes investigations to date:

1. Project: Plasma α-Tocopherol and Retinol Levels in Captive Rhinoceros Species

   Researcher: Dr. Ellen S. Dierenfeld, New York Zoological Society, Bronx, NY 10460

   Blood samples obtained from 8 black rhinos in North American zoos contained an average of 0.37 + 0.07 μg/ml α-tocopherol, and 0.07 ± 0.01 μg/ml retinol. These values were obtained from animals not on supplementation studies, and may, in fact, show an overall increase in circulating vitamin E levels in the captive rhinoceros population (up from 0.2 μg/ml reported in 1988). A single sample from the Leipzig Zoo had an unquantifiable vitamin E level, and a retinol value of 0.09 μg/ml.

   Eighteen plasma samples processed from black rhinos supplemented at varying levels with one or both products described above displayed a mean circulating α-tocopherol value of 0.89 ± 0.22 μg/ml.

   White rhinoceros (n=4) samples contained an average of 1.04 ± 0.17 μg/ml α-tocopherol, and 0.08 ± 0.01 μg/ml retinol.

2. Project: Plasma Lipoprotein Characteristics in Rhinos

Researcher: Dr. Maret G. Traber, New York University School of Medicine, New York, NY 10016

Vitamin E is transported in plasma lipoproteins; thus the type of lipoprotein carrier may influence the amount of this nutrient that can be carried and distributed to tissues. In an effort to better document transport mechanisms of fat-soluble vitamins in this species, Dr. Traber has examined lipoprotein distribution in plasma samples from both black and white rhinoceros, and compared profiles with other Perissodactyla and elephants. High density lipoproteins (HDL) represent more than 80% of the lipoproteins in domestic and exotic equids, and 60% in tapirs, but no HDL was detected in rhinoceros plasma. The lack of HDL may be one reason for low circulating α-tocopherol levels in rhinoceros. However, lipoprotein patterns did not differ between white and black rhinoceros samples, yet plasma levels differ considerably. Thus other factors are involved in observed species differences.

2. Project: Tissue Tocopherol Distribution

Researcher: Dr. Ellen S. Dierenfeld, New York Zoological Society, Bronx, NY 10460.

Vitamin E levels in rhinoceros liver, skeletal muscle, heart, and adipose tissue have been examined in samples obtained from 3 white rhinos, and 6 black rhinos sampled at necropsy. Species differences between the grazing white rhinoceros and browsing black rhinoceros were evident; higher overall tissue storage (thus vitamin E status) was seen in black rhinos compared with whites, with tissue levels 2-4 times higher in the blacks. This is in sharp contrast to that predicted from more readily obtained plasma samples, and may reflect the recognition of a need for dietary vitamin E supplementation of black rhinos which has not been specifically identified for the whites.

3. Project: Liver Tocopherol Binding Protein

Researcher: Dr. Maret G. Traber, New York University School of Medicine, New York, NY 10016

Within the coming year, Dr. Traber will be attempting to isolate a suspected tocopherol-binding protein from liver samples obtained opportunistically from both black and white rhinoceros. Possible species differences in concentration of this protein are hypothesized to account for observed differences in tissue and plasma levels between these species.

4. Project: Nutritional Studies

Researchers: Dr. Craig Thatcher, Virginia-Maryland Regional College of Veterinary Medicine, Balcksburg, VA 24601; Dr. R. Eric Miller, St. Louis Zoological Park, St. Louis, MO 63110.

Dr. Thatcher is assembling a team of researchers (nutritionists, veterinarians, and an epidemiologist) to review current data and develop further studies evaluating black rhinoceros nutrition. A proposal is being developed to evaluate sera samples from 20+ captive and 40+ wild (Zimbabwe) black rhinoceros for multiple minerals and micronutrients. Additional studies, eg, feed intake trials, may be designed to evaluate feeding practices in captivity and the nutritional plane of the captive North American black rhinoceros population.

Respectfully submitted,

Ellen S Dierenfeld

Ellen S. Dierenfeld, PhD
New York Zoological Society

11 September 1991

DEC 10 1990

AROUND THE HORN
The Rhino Conservation Newsletter
AUTUMN 1990 Volume 1 Number 3

VITAMIN E LEVELS MEASURED IN RHINO BROWSE PLANTS

Study should provide guidelines for vitamin E supplementation in captive rhinos

By Ellen S. Dierenfeld

Previous work from our laboratory and others has documented differences in plasma alpha-tocopherol levels between zoo (0.2 micrograms/ml) and free-ranging (0.8 micrograms/ml) black rhinos, and suggested that many captive animals may be suffering from vitamin E deficiency. This original comparison was conducted on blood samples (n=31) taken during a translocation operation in Zimbabwe in 1988. Subsequent to that study, we quantified plasma alpha-tocopherol from 44 free-ranging black rhinos sampled in South Africa, 7 in Kenya, 4 in Namibia, and an additional 24 animals in Zimbabwe. These latter results averaged 0.6, 0.2, 0.8 and 0.5 micrograms/ml, respectively.

Because plasma and dietary levels of alpha-tocopherol (as a measure of vitamin E activity) are closely correlated, the differences seen among these various rhino populations suggested widely varying diets and/or habitat quality. To investigate this possibility, a collaborative field study with F. Kamunde Waweru, Wildlife Conservation International, Kenya, R. duToit, Zambezi Rhino Project, and R. Brett, World Wildlife Fund, Kenya, was organized to quantify alpha-tocopherol levels in major browse species consumed by black rhinos. Four locations in Kenya (2 national parks, 2 private reserves) and the Zambezi Valley, Zimbabwe, were chosen as study sites.

Tocopherols must be extracted from fresh plant tissues, and, to our knowledge, have not before been measured in a field study. In order to do so, a portable laboratory containing necessary chemicals and a hand held homogenizer, as well as a full-sized tank of nitrogen gas, were loaded into vehicles and driven to makeshift labs. Converted storerooms or kitchens generally met our relatively minor requirements of counter space, an electrical source, and water, although we were treated to a true lab space at the Rukomechi Tsetse Fly Research Station in the Zambezi Valley! Samples were weighed, homogenized, extracted, evaporated, reconstituted, sealed, and freezer-stored until shipment back to the States for analysis via high-performance liquid chromatography.

(See BROWSE on Page 2)

F. Kamunde Waweru and Dr. Ellen Dierenfeld separating leaves from stems in fresh rhino browse gathered in Nairobi National Park. (Photo provided by E. Dierenfeld)

BROWSE from Page 1

African collaborators, all experienced field researchers, identified major food plants (a minimum of 10 species per site) for sampling. Results indicated wide variation in vitamin E levels in fresh rhino browse plants. Leaves contained 2- to 50-fold more alpha-tocopherol than stem portions of the same plant; mature tissues had higher concentrations than young, growing tissues. Environmental variables appeared to influence vitamin E levels in browse significantly, but were not quantified for this preliminary study. Rainfall, temperature and sunlight effects on alpha-tocopherol metabolism in plants are currently being examined in controlled greenhouse studies.

Whole plants ranged from 4.1 (Acacia drepanolobium) to 420.9 (Scutia myrtinus) mg alpha-tocopherol/kg dry matter [equivalent to 6-630 International Units of Vitamin E activity/kg (1 mg = 1.49 IU)]. Dietary levels of alpha-tocopherol from various locations (unweighted means) did not correlate well with the plasma levels previously quantified from animals in the various sites. For example, the Zambezi Valley plants (n = 27) averaged 45.5mg/kg alpha tocopherol (range 6.4 to 191.8) whereas the Kenyan location from which animals with the lowest plasma alpha-tocopherol had been bled averaged 154.2 (range 21.2 to 420.9). Reasons for this apparent discrepancy are being investigated.

Nonetheless, about 80% of the plants sampled contained vitamin E levels > 50 IU/kg, the current National Research Council recommendation for dietary vitamin E in horses. These data, although limited, should provide excellent guidelines for use in formulating appropriate levels of vitamin E supplementation for zoo rhinoceros. Based on these field observations, diets fed to black rhinos should contain a minimum of 150 IU, and more likely 250 IU vitamin E/kg dry matter.

Future projects will be designed to investigate seasonal and other environmental as well as physical (i.e. fire, grazing pressure) influences on vitamin E in plants, in an effort to refine not only herbivore feeding recommendations, but also plant conservation in relevant locations.

BLACK RHINOS SOLD TO PRIVATE OWNER IN SOUTHERN AFRICA

History was made on June 18, 1990 when the Natal Parks Board auctioned a founder population of five black rhino to a privately owned nature reserve. Lapalala Wilderness successfully bid 2.2 million rand for the two bulls and three cows.

Because the black rhino is so highly endangered, South Africa, like Kenya and Zimbabwe, is turning to controlled breeding in small, discrete reserves to ensure the species' survival. Assessments by the Natal Parks Board and Peter Hitchins, a black rhino specialist, found the 24,400 hectare Lapalala Wilderness to be one of eight private reserves in southern Africa considered suitable for black rhino introduction. It is located in the Waterberg Mountains in the northwestern part of the Transvaal province, a region from which black rhinos have been absent for over 100 years.

The rhinos' 900 kilometer trip to Lapalala Wilderness was supervised by Dr. Martin Brooks of the Natal Parks Board. On August 8, 1990, the animals were immobilized by Parks Board veterinarian, Peter Rogers, at which time body measurements were taken and ears were notched for future field identification. Also at this time, the tip of each rhino's horn was cut off as a precaution against injury to one another. The horn tips will be used in a DNA fingerprinting study being undertaken by Dr. Anthony Hall-Martin of the National Parks Board of South Africa.

Upon their arrival on August 9, they were released into specially constructed burmas within a 10,000 hectare game-fenced section of Lapalala Wilderness to undergo a settling in period before their release. As of October 12, 1990, the rhinos were still being held in the burmas and doing very well. The release process was to begin in late October, 1990, after the rainy season had commenced and the quality of the habitat had improved.

Clive Walker of Lapalala Wilderness admits that there is some controversy about turning black rhinos over to private owners, but he believes most would agree that it is wise and that it will continue to occur. The significance of the event to the private sector can be ascertained from the price that was paid for the privilege of acquiring the five rhinos. As stated by Clive Walker, "This is a great responsibility for us at Lapalala Wilderness. This opportunity arises from the confidence the Natal Parks Board has placed on the private sector in allowing these animals to go onto private land. We are only too aware of what has happened to the black rhino across Africa; southern Africa is their last stronghold and we are happy to be part of their conservation. A great deal will be expected of us and we will have to measure up to those expectations."

The Lapalala transaction was of great economic benefit to the Natal Parks Board because sale proceeds were used to provide important funding for its various conservation management programs. Of even greater significance, however, was the fact that for the first time ever in South Africa, black rhinos were assigned an economic value. This could potentially prove helpful in the courtroom, as judges can now take into consideration a replacement cost in assessing penalties against rhino poachers. Increased fines and stiffer sentences are being called for in the South African judicial system where the current penalty for rhino poaching is only 1,500 rand, or one year in jail.

RHINO GLOBAL CAPTIVE ACTION PLAN WORKSHOP

BRIEFING BOOK

LONDON ZOOLOGICAL GARDENS
9-10 MAY 1992

SECTION 15

DISEASE

VETERINARY WORKING GROUP REPORT FROM 1991 INTERNATIONAL RHINOCEROS CONFERENCE IN SAN DIEGO

In view of the role that health and nutritional problems have had in the maintenance of captive rhino populations (e.g., as a limiting factor in the growth of the captive black rhino population), and that they have presented concerns in wild populations and their translocations, the following points for consideration and action are recommended:

I. Continued investigation of health problems in wild and captive rhinos is needed. New and continued research should be organized and encouraged in the following areas:

A. All morbidity and mortality data from captive and where possible, wild populations should be compiled and reviewed annually under the auspices of the regional species management plans and national wildlife programs, and those regional data reviewed under the auspices of the IUCN/CBSG Rhinoceros Action Plan. Such studies should include evaluation of post-capture and post-translocation mortalities.

B. Further investigation of the incidence and prevention of management-related disease, trauma and infertility should occur.

C. Monitoring the fertility of all rhino populations, with particular attention to greater one-horned Asian rhinos and abortion rates in black rhinos, should be emphasized.

D. Enhancement of baseline data ("normal" values) from free-ranging and captive rhinos of all species is of critical importance to all fields of research.

E. Epidemiology of health problems in captive and wild rhinos should be studied and compared. Research should include seroprevalence surveys for infectious diseases and evaluation of internal and external parasites and their significance to rhino health.

F. Continued sharing and refinement of immobilization regimens among field and zoo veterinarians should take place. Narcotic agents (etorphine and carfentanil) are the primary drugs used for immobilization, and further investigations are needed to establish preferable supplemental tranquilizers, particularly long-acting neuroleptic agents.

G. Metabolic consequences of anesthesia and the stresses associated with capture and the sequelae to both should be assessed.

H. Studies to address the immune status of wild and captive rhinos and the role that immunology may play in several of their diseases, e.g. fungal pneumonia of black rhinos, should be initiated.

I. Nutritional research should include a general review of the feeding practices used in all species in captivity, with particular attention to establishing minimal requirements. Basic nutritional evaluations should focus attention on the nutrition of both wild and captive populations, and the resultant comparisons. Research to establish effective dietary supplementation with alpha-tocopherol should be encouraged.

J. In black rhinos, further research should be designed to evaluate the following diseases and syndromes:

1) Hemolytic anemia - Current recommendations for the prevention of acute hemolytic anemia include the vaccination of captive animals with a bacterin containing 5 leptospiral serovars. Research to identify an underlying cause for the hemolysis should continue.

2) Oral/skin ulcers - Ongoing efforts to identify the patho-physiology of the ulcers should be encouraged.

3) Iron metabolism - Further evaluation is needed regarding the accumulation of hepatic iron in captive and newly captured black rhinos.

4) Fungal pneumonia

5) Encephalomacia

II. In conjunction with the preceding proposals, identification of additional funding sources to support health research in rhinos is vital.

III. Continued maintenance and enhanced participation in regional biomaterial banks (tissue, sera, urine, etc.), with samples from both captive and wild rhinos of all available species is vital to future comparative studies.

IV. Continued and enhanced collection of genetic samples from anesthetized rhinos whenever possible should continue to be encouraged.

V. Communication among veterinarians working with wild and captive rhinos should be continued and enhanced through future meetings. Special effort should be given to the maintenance of continuous medical histories for rhinos translocated from the wild to captivity.

(See VETERINARY on Page 9)

AROUND THE HORN

The Rhino
Conservation
Newsletter

APRIL 1992

VETERINARY from Page 7

In summary, there should be veterinary participation in the management of captive and wild rhino populations. This participation should be an integral part of a multidisciplinary approach to their care, and is particularly relevant to their capture and translocation. Such efforts will contribute to the long term survival of both *in situ* and *ex situ* rhino populations.

Saint Louis ZOO

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Charles H. Hoessle
Director

Robert Hyland
President, Zoological Commission

BLACK RHINOCEROS VETERINARY RESEARCH UPDATE
1991

R. Eric Miller, DVM
Veterinary Advisor
Black Rhinoceros (Diceros bicornis) SSP Committee
Rhinoceros Taxon Advisory Group

Under the auspices of the SSP, animal health research in the black rhinoceros is an ongoing effort. This report will serve as an update to the 1990 veterinary report to the Black Rhinoceros SSP. Obtaining tissue and sera from all species of captive and wild rhinoceroses remains a priority. Central storage facilities exist for formalinized rhinoceros tissues (Dr. Richard Montali, National Zoological Park) and for frozen serum and tissue (Dr. Eric Miller, St. Louis Zoological Park). These banks have provided readily available sources of materials for comparative and retrospective studies. "Normal" values from wild black rhinoceroses (80+ animals) in Zimbabwe has been published by Dr. Michael Kock, Raoul du Toit, et. al. (1).

Four diseases in black rhinoceroses continue to be notable for their unusual nature and relatively high frequency of occurrence. Although hemolytic anemia has been the leading cause of death among captive animals (43 episodes of hemolysis noted in 34 rhinoceroses; 23 rhinoceroses died from their anemia), no deaths from "primary" hemolysis (not associated with other systemic disease) have been noted since 1986. It is too soon to determine the full significance of this, but it may be a hopeful sign that leptospirosis vaccination and dietary improvements have had some effect. Additionally, no new cases of encephalomalacia have been identified since 1988.

Fungal pneumonias (Aspergillus and less commonly phycomycetes) continue to be noted; at least 6 cases have been identified in black rhinoceroses in North America. Four occurred in black rhinoceroses receiving immunosuppressive therapy for other conditions and 2 cases were "spontaneous." The occurrence of these infections suggests an altered immunological response and has led to research on the immune status of black rhinoceroses (see Dr. Slavin's project below, Dr. Herron's project on the 1990 report). Last, but not least, is the occurrence of oral/skin ulcers. Twenty-six cases have been noted, ranging from mild skin ulcers to severe ulcerative lesions of the skin, mucosal junctions and gastrointestinal tract. Death may result from secondary complications. Dr.

Linda Munson is reviewing tissues from these cases (see description of her project below).

Prior to the 1991 International Rhinoceros Conference at the San Diego Zoo, Dr. David Jessup (International Wildlife Veterinary Services) organized a meeting of veterinarians active in rhinoceros medicine and research. Attendees represented zoo and wildlife veterinarians from the US, Great Britain, Zimbabwe and Namibia. The meeting presented an excellent opportunity for wildlife and zoo veterinarians to share clinical and research experiences and to identify areas of common interest and cooperation. A statement that resulted from this meeting and the Veterinary Session of the Rhinoceros Conference is attached. Two areas were identified that warrant further research: 1) immunological function (for reasons noted above) and 2) additional nutritional studies.

Following is an updated list of animal health projects that have either been initiated or active in the past year:

1. <u>Project</u>: T-Lymphocyte Stimulation Testing and Immunological Evaluation for Fungal Infections.
   Researchers: Dr. Raymond Slavin and Dr. Allan P. Knutsen, St. Louis University School of Medicine, St. Louis, MO 63104, and R. Eric Miller, DVM, St. Louis Zoological Park, St. Louis, MO 63110, USA.

   Currently being designed, this project will employ various immunological tests to identify black rhinoceroses infected with <u>Aspergillus</u> sp. (primarily pneumonia as noted above) and to evaluate their response to fungal organisms. A more general immunological study will evaluate the response of black rhinoceros lymphocytes to in mitogen stimulation studies.

2. <u>Project</u>: Nutritional studies

   Researchers: Dr. Craig Thatcher, Virginia-Maryland Regional College of Veterinary Medicine, Blacksburg, VA 24601, USA, R. Eric Miller, DVM, St. Louis Zoological Park, St. Louis, MO 63110, USA.

   See Nutritional Report to the Black Rhinoceros SSP Committee.

3. <u>Project</u>: Evaluation of oral and skin ulcers

   Researcher: Dr. Linda Munson, College of Veterinary Medicine, University of Tennessee, Knoxville, TN 37901-1076, USA.

   Due to the occurrence of oral and/or skin ulcers in captive black rhinoceroses (3), biopsy and postmortem tissues from all cases are being reviewed by Dr. Munson. Twenty-six captive black rhinoceroses in the US have had mucosal and/or cutaneous ulcers; 3 cases have been noted in the past year. Most of the rhinoceroses have had recurrent ulcers. Microscopically, the oral and skin lesions appear as chronic ulcers, though, as of yet no single histologic pattern has emerged. In these captive rhinoceroses there has been no evidence of the dirofilarid parasite *Stephanofilaria dinniki*. The etiology remains unknown. Dr. Munson is preparing a paper describing the ulcerative "syndrome."

4. *Project:* Leptospirosis evaluation by microagglutination titers and fluorescent antibody testing.

Researcher: Dr. Carol Bolin, National Veterinary Services Laboratory, Ames, IA 50010, USA

On the basis of fluorescent antibody (FA) tests, infection with *Leptospirosis interrogans* has noted in 3 of 4 cases of fatal hemolytic anemia in black rhinoceroses (2). Additionally, in the past year, another FA+ case was noted in a female that died in 1990 at the Cincinnati Zoo with severe skin ulcers and anemia. The relationship of *L. interrogans* infection with disease in this animal is unclear. Currently titer data from captive and wild (Zimbabwe samples supplied by Drs. Michael and Nancy Kock and David Jessup and Raoul du Toit, Namibian samples supplied by Dr. Peter Morkel and Louis Geldenhuys) are being submitted for publication. Of interest is evidence of exposure to varying serovars (strains) of *L. interrogans* in different areas of Zimbabwe and Namibia (no evidence of exposure in 3 rhinoceroses from the latter's arid habitat). The presence of infection with *L. interrogans* in some of the hemolytic cases and the titer data continue to support the previous recommendation that all black rhinoceroses be vaccinated biannually with a bacterin that contains at least 5 serovars of *L. interrogans* including *icterohaemorrhagiae* and *grippotyphosa*. Leptoferm-5 (Norden Laboratories, Lincoln, NE 80809, USA) is recommended. Opportunistic postvaccinal sampling of black rhinoceros continues to demonstrate responses in microagglutination titers that would be considered appropriate and protective in domestic species.

Note: Though leptospiral infection may be indicated in 50%-75% of the fatal cases of hemolytic anemia, it is important to note that it has not been identified in all cases. Ongoing studies are attempting to identify other factors that may contribute to red blood cell instability.

5. Project: Further evaluation of red blood cell metabolism.

Researcher: Dr. Donald Paglia, University of California - Los Angeles, Los Angeles, CA 90024, USA

ATP levels in the black rhinoceros RBC are approximately 5% - 20% of those in most other mammalian species. The impact of this finding is uncertain, but it raises the possibility that the black rhinoceros RBC may use alternative energy pathways (4). Further analysis of rhinoceros RBC metabolism and substrate usage is ongoing at UCLA as heparinized blood samples become available. Funding sources need to be identified to maintain and continue this project.

6. Project: Aspergillus sp. pneumonia in black rhinoceroses.

Researcher: Dr. Scott Citino, Metro Miami Zoo, Miami, FL 33176, USA and Dr. Eric Miller, St. Louis Zoological Park, St. Louis, MO 63110, USA.

Fungal pneumonia caused by Aspergillus sp. has been noted in at least 6 captive black rhinoceroses. At least 4 of the 6 affected animals were on immunosuppressive therapy for ulcers (see Dr. Munson's project above). However, 2 of the cases were apparently spontaneous. The occurrence of fungal pneumonia in captive black rhinoceroses warrants further studies regarding their immunocompetence (see Dr. Slavin's project).

7. Project: Cross matching of black rhinoceros sera and red blood cells

Researcher: Dr. Ann Bowling, School of Veterinary Medicine, University of California, Davis, CA 95616

Red blood cells (citrated samples) from 9 black rhinoceroses have been cross-matched with sera from 18 black rhinoceroses. In agglutination testing, weak to moderate reactions have been observed in 13 of the 18 sera samples. One sera sample has produced weak lytic reactions against 7 of the 8 animals tested. Interpreted in light of experience in domestic animals, no evidence has been found that would suggest a clinically obvious problem being defined by these tests. However, it is tempting to speculate that a pattern is emerging from these reactions which may define one or more naturally occurring anti-red cell antibodies. Hopefully, further samples will help in interpreting these observations.

8. Project: Complete blood counts and serum chemistries.

Researcher: Dr. Steven Stockham, College of Veterinary Medicine, University of Missouri, Columbia, MO 65211

Because of variability between laboratory methods, a request was made that complete blood counts and serum chemistries from all rhinoceroses be submitted to a central laboratory. To date, 35 samples have been received from 15 black and 6 white rhinoceroses. Data are currently being reviewed.

9. Project: Serum iron levels and iron binding proteins

Researcher: Dr. Joseph Smith, College of Veterinary Medicine, Kansas State University, Manhattan, KS 66506

Due to the elevated tissue levels of iron noted at necropsy in many black rhinoceroses, additional tissue iron levels from necropsies and serum levels of iron and iron transporting proteins in living animals are being assayed. Thirty-seven sera samples (29 black, 7 white, and 1 Indian), and 17 liver and/or splenic samples (14 black, 3 white) samples have been evaluated. When the data from black rhinoceroses are compared to the white rhinoceroses included in the study, they do not appear to differ significantly. Further analysis is underway to determine if initial impressions that black rhinoceroses accumulate iron in the liver and spleen as they age, and if the serum iron and TIBC of adult black rhinoceroses are higher than that of younger animals or white rhinoceroses.

10. Project: Evaluation for hepadnovirus.

Researcher: Dr. Mike Worley, Zoological Society of San Diego, San Diego, CA 92103, USA.

This study continues to evaluate rhinoceros serum samples for antibodies to hepatitis B-like virus. Additional testing is in progress in an attempt to more definitively identify viral isolates.

-next page-

BLACK RHINOCEROS DEATHS IN NORTH AMERICA

1991

STDBK # NAME	SEX	DOB	DOD	CAUSE OF DEATH
239 Nanyuki SD-WAP	F	15OCT76	13JUN91	Ruptured liver, trauma
2066 No Name Bentsen	M	20JUL91	20JUL91	Weak, possibly premature

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2. Miller, RE, CA Bolin: Evaluation of leptospirosis in black rhinoceroses (*Diceros bicornis*) by microscopic agglutination and fluorescent antibody testing. *Proc. Am. Assoc. Zoo Vet.*, pp. 161-162, 1988.

3. Ott, JE, SE McDonald, PT Robinson, FH Wright: Ulcerative stomatitis in a black rhinoceros (*Diceros bicornis*). *Proc. Am. Assoc. Zoo Vet.*, pp. 68-71, 1982.

4. Paglia, DE, WN Valentine, RE Miller, M Nakatani, RA Brockway: Acute intravascular anemia in the black rhinoceros (*Diceros bicornis*) - II. Erythrocytic enzymes and intermediates. *Am. J. Vet. Res.* 47: 1321-1325, 1986.

Respectfully submitted,

R. Eric Miller, DVM
Associate Veterinarian
St. Louis Zoological Park

September 1, 1991

INTERNATIONAL RHINOCEROS CONFERENCE - SAN DIEGO 1991
VETERINARY WORKING GROUP/SESSION REPORT

In view of the role that health and nutritional problems have had in the maintenance of captive rhinoceros populations (eg, as a limiting factor in the growth of the captive black rhinoceros population), and that they have presented concerns in wild populations and their translocations, the following points for consideration and action are recommended:

1. Continued investigation of health problems in wild and captive rhinoceroses. New and continued research should be organized and encouraged it the following areas:

   - All morbidity and mortality data from captive, and where possible, wild populations should be compiled and reviewed annually under the auspices of the regional species management plans and national wildlife programs, and those regional data reviewed under the auspices of the IUCN/CBSG Rhinoceros Action Plan. Such studies should include evaluation of post-capture and post-translocation mortalities.

   - Further investigation of the incidence and prevention of management related disease, trauma and infertility.

   - Additionally, monitoring the fertility of all rhinoceros populations with particular attention to Indian rhinoceroses and abortion rates in black rhinoceroses should be emphasized.

   - Enhancement of baseline data ("normal" values) from free-ranging and captive rhinoceroses of all species is of critical importance to all fields of research.

   - Epidemiology of health problems in captive and wild rhinoceros populations and comparison of patterns in each. Such research should include seroprevalence surveys for infectious diseases and evaluation of internal and external parasites and their significance to rhinoceros health.

   - Continued sharing and refinement of immobilization regimens between wildlife and zoo veterinarians should take place. Narcotic agents (etorphine and carfentanil) are the primary drugs used for immobilization, and further investigations are needed to establish preferable supplemental tranquilizers, particularly long-acting neuroleptic agents.

   - Metabolic consequences of anesthesia and the stresses associated with capture and the sequelae to both should be assessed.

   - Studies to address the immune status of wild and captive rhinoceroses and the role that immunology may play in several of their diseases, eg, fungal pneumonia of black rhinoceroses, should be initiated.

- Nutritional research should include a general review of the feeding practices used in all species in captivity with particular attention to establishing minimal requirements. Basic nutritional evaluations should focus attention on the nutrition of both wild and captive populations, and the resultant comparisons. Research to establish effective dietary supplementation with alpha-tocopherol should be encouraged.

- In black rhinoceroses, further research should be designed to evaluate the following diseases and syndromes:

  Hemolytic anemia - Current recommendations for the prevention of acute hemolytic anemia include the vaccination of captive animals with a bacterin containing 5 leptospiral serovars. Research to identify an underlying cause for the hemolysis should continue.
  Oral/skin ulcers - Ongoing efforts to identify the pathophysiology of the ulcers should be encouraged.
  Iron metabolism - Further evaluation due to the accumulation of hepatic iron in captive and newly captured black rhinoceroses.
  Fungal pneumonia
  Encephalomalacia

2. In conjunction with the above proposals, identification of additional funding sources to support health research in rhinoceroses is vital.

3. Continued maintenance and enhanced participation in regional biomaterial banks (tissue, sera, urine, etc.) with samples from both captive and wild rhinoceroses of all available species is vital to future comparative studies.

4. Continued and enhanced collection of genetic samples from anesthetized rhinoceroses whenever possible should continue to be encouraged.

5. Communication between veterinarians working with both wild and captive rhinoceroses should be continued and enhanced through future meetings. Special effort should be given to the maintenance of continuous medical histories for rhinoceroses translocated from the wild to captivity.

In summary, there should be veterinary participation in the management of captive and wild rhinoceros populations. This participation should be an integral part of a multidisciplinary approach to their care, and is particularly relevant to their capture and translocation. Such efforts will contribute to the long term survival of both _in situ_ and _ex situ_ rhinoceros populations.

Submitted by : R. Eric Miller, DVM
Veterinary Working Group/Session Chair

Saint Louis ZOO

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Charles H. Hoessle
Director

Robert Hyland
President, Zoological Commission

February 6, 1992

Dr. Thomas Foose
CBSG
c/o Minnesota Zoological Gardens
13000 Zoo Boulevard
Apple Valley, MN 55124

Dear Tom:

Please find enclosed a copy of Dr. Paglia's notification and of my proposed draft to be distributed to black rhinoceros holding institutions. I will be out of the office tomorrow, but I will try to get a letter to you next week requesting CBSG dissemination these findings (and a short blurb for the Newsletter) and one off to Mike Hutchins for a Communique entry.

Thanks for your interest, and please let me know if you have nay further suggestions for distribution.

Sincerely,

Eric

R. Eric Miller, DVM
Associate Veterinarian

Summary of Recent Observations Regarding Rhinoceros Erythrocyte Metabolism

(Supplement to project proposal, entitled " The Metabolic Basis of Acute Episodic Hemolytic Anemia in the Black Rhinoceros (Diceros bicornis), submitted to Wildlife Conservation International 30 August 1991.)

Studies conducted on blood specimens from three additional black rhinoceroses obtained in September and November 1991 confirm the preliminary data presented in Figure 1 of the proposal. It is now clear that incubation of salinewashed erythrocytes with 1 mM adenosine and 5 mM glucose consistently results in linear increases of intracellular ATP and total adenine nucleotides, reaching 10- to 20 - times initial concentrations after 4 hrs, (levels that are equivalent to those found normally in humans and most other mammalian species.)

Development of this in vitro method of altering the ATP content of rhinoceros erythrocytes now provides us with an experimental system to test several hypotheses in our original proposal. We have recently discovered that exposure of whole blood to oxidants such as acetylphenylhydrazine (APH), induces rapid loss of reduced glutathione, despite hyperactivity of enzymes in the hexosemonophosphate shunt (which is principally responsible for antioxidant metabolic activity).

Figure 4 presents the average response of erythrocytes from these three rhinoceroses to APH exposure in Beutler's classical glutathione stability test (23) compared to a typical normal human control. In two animals so far studied, marked glutathione instability was entirely corrected by preincubation of erythrocytes with adenosine and glucose, lending strong support to our hypothesis that inherently low ATP concentrations in rhinoceros erythrocytes compromise antioxidant response by restricting substrate (glucose-6-phosphate) availability for hexosemonophosphate shunt metabolism. This is additionally consistent with our hypothesis that hemolytic episodes in the black rhinoceros are analogous to glucose-6-phosphate dehydrogenase (G-6-PD) deficiency in humans.

Using this same incubation system, we intend to test the effect of ATP concentration on erythrocyte susceptibility to intracellular generation of $H_2 O_2$ by phenazine methosulfate according to the method of Nishikimi et al (24). This system additionally provides us with a mechanism to test in vitro the potential hemolytic effects of various drugs, chemicals, plant extracts or other agents which have been implicated in the induction of hemolysis in black rhinoceroses. By coupling this system with in vitro culture techniques for various infectious agents we can potentially test the hypothesis that low ATP concentrations confer a selective evolutionary advantage to rhinoceros erythrocytes in a manner analogous to the protective effect of human G-6-PD deficiency against malignant falciparum malaria.

Supplement References

(23) Beutler E. The glutathione instability of drug-sensitive red cells. J Lab Clin Med 49:84,1957.

(24) Nishikimi M, Appaji N, Yagi K. The occurrence of superoxide anion in the reaction of reduced phenazine methosulfate and molecular oxygen. Biochem Biophys Res Commun 46:849,1972.

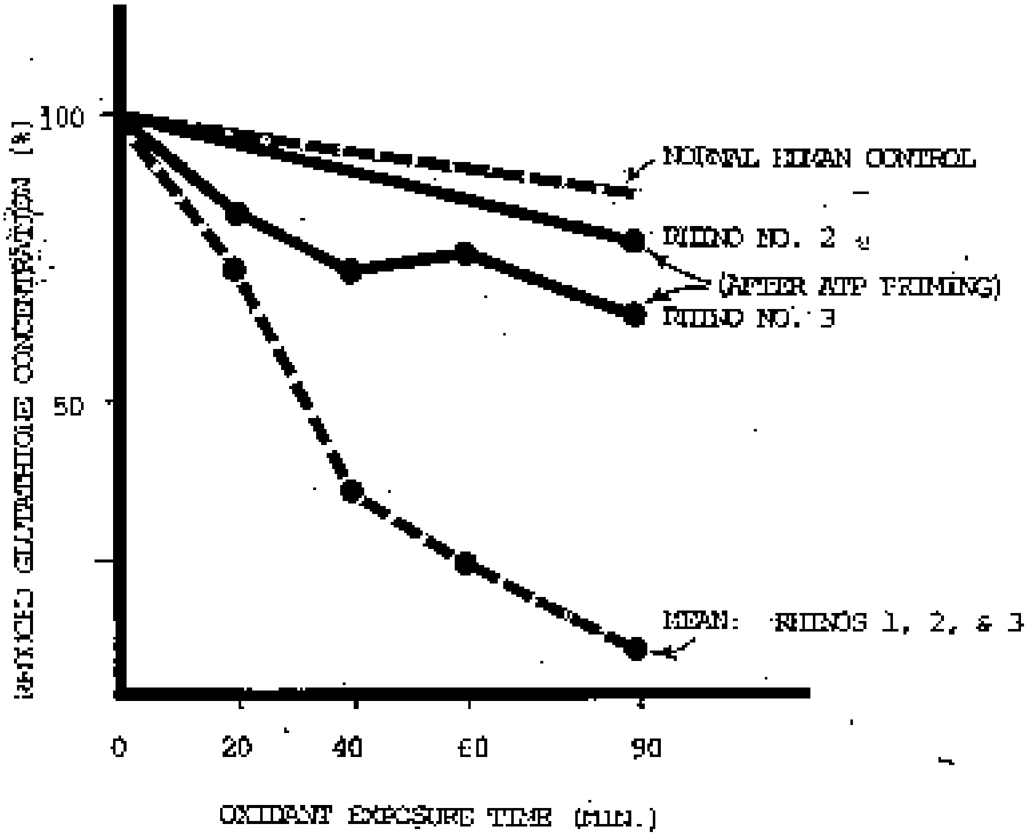

Figure 4. Glutathione stability of native rhinoceros erythrocytes (mean of three) compared to two samples preincubated with adenosine and glucose to increase ATP concentrations and to a typical normal human control.

DRAFT

January 21, 1992

Dr. Mark Campbell
Cincinnati Zoological and Botanical Gardens
3400 Vine Street
Cincinnati, OH

Dear __________:

Please find enclosed a notice of recent findings from Dr. Paglia's red blood cell enzyme metabolism laboratory at UCLA. His studies have focused on the metabolism of the black rhinoceros (*Diceros bicornis*) red blood cell[1] in order to evaluate the hypothesis that an underlying defect in energy metabolism may make these cells susceptible to oxidant stress and subsequent hemolysis. Although these findings are preliminary, we believe them significant and warranting distribution.

As you can see, his studies indicate that black rhinoceros red blood cells are notably energy deficient as they contain only 2%-5% of the ATP (energy) levels of human and most other mammalian red blood cells (echidnas are an exception and certainly a phylogenetic leap from rhinos!). Further studies in black rhinoceros are attempting to determine a heritable basis for the deficiency.

Although a different enzyme system is involved, it is similar to glucose-6-phosphatase dehydrogenase (G-6-PD) deficiency of man. Affected individuals can lead relatively normal lives until an oxidant stress triggers hemolysis. Such a deficiency in man or rhinoceroses can be a "common denominator," allowing a number of oxidant stresses to produce the same result - hemolysis.

Until we know more, particular attention should be paid to avoiding the use in rhinoceroses of numerous drugs and agents that induce hemolysis in G-6-PD deficient patients and other species (listed in the last 2 paragraphs of his report). Leptospirosis has been identified or incriminated in a number of hemolytic cases, and these findings may also explain the peracute hemolysis associated with this infection. Thus, we continue to recommend biannual vaccination with a 5-way leptospiral bacterin (Leptoferm 5, Norden).

-next page-

I would like to thank all the zoological institutions and veterinarians who supplied samples for this and other projects concerning the health of captive black rhinoceroses. Dr. Paglia is still interested in further samples; should they become available, you may reach him at (213) 825-1614.

In a final note, on behalf of the rhinoceros research community, I would like to thank Dr. Paglia for his persistence, dedication and determination in identifying an underlying cause to the hemolysis of black rhinoceroses in captivity. This project is currently at a critical stage and we are currently attempting to identify funding sources for its continuance. If you know of any agencies that might be interested, please contact us.

If you have any questions or comments, please do not hesitate to contact myself, or Dr. Paglia directly.

Sincerely,

R. Eric Miller, DVM
Veterinary Advisor,
Black Rhinoceros
SSP
Rhinoceros TAG

[1] Paglia, DE, WN Valentine, RE Miller, M Nakatani, RA Brockway: Acute intravascular hemolytic anemia in the black rhinoceros (<u>Diceros bicornis</u>) - II. Erythrocytic enzymes and intermediates. <u>Am. J. Vet. Res.</u> 47:1321-1325, 1986.

Foose

Saint Louis ZOO

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Charles H Hoessle
Director

Robert Hyland
President, Zoological Commission

February 19, 1992

Dr. Thomas Foose
Captive Breeding Specialist Group
c/o Minnesota Zoological Gardens
13000 Zoo Boulevard
Apple Valley, MN 55124

Dear Tom:

Please find enclosed a short article regarding the significance of Dr. Paglia's recent findings on the metabolism of the black rhinoceros red blood cell. He rewrote an initial article and I think successfully eliminates much of the technical jargon and summarizes the practical aspects of it. If you need to cite authors (not necessary from our end), please place his name first, then mine. If you want to give it a more interesting tittle (eg, Hemolytic Anemia in Black Rhinoceroses - An Underlying Cause?), please feel free to do so.

The letter that I sent you and Dr. Paglia's original report have been distributed to the attached list that includes veterinarians at all North American holding institutions (#1-28), field veterinarians in Zimbabwe (and Raoul du Toit) and Namibia, black rhinoceros coordinators in Australia/New Zealand and Europe, and other researchers involved in black rhinoceros hematology projects (#29-52). Betsy Dresser is sending me a list of institutions representatives and I will also forward it to them. If you have any other suggestions for distribution, please let me know and I will send it out.

Thanks again for your help.

Sincerely,

Eric

R. Eric Miller, DVM
Associate Veterinarian

INCREASED SUSCEPTIBILITY OF BLACK RHINOCEROS (*Diceros bicornis*) RED BLOOD CELLS TO OXIDANT STRESS AND CONSEQUENT HEMOLYSIS

Hemolytic anemia has been the leading cause of mortality among captive black rhinoceroses: 23 of 31 affected by hemolytic crises have died. Similar hemolytic syndromes occur frequently in man and other mammals and many can be ascribed to enzymatic defects that impair metabolic pathways responsible for oxidant neutralization. Human glucose-6-phosphate dehydrogenase (G-6-PD) deficiency is the paradigm for such disorders: most affected individuals are clinically normal until exposed to an agent that induces sudden oxidant stress, triggering an acute hemolytic episode.[1] There is strong evidence that the persistence and prevalence of G-6-PD deficiency in humans result from its protective effect against malarial parasitism.

Studies at the UCLA Hematology Research Laboratory indicate that an analogous metabolic defect exists in rhinoceros erythrocytes that may also provide a selective evolutionary advantage against chronic hemic parasitism. The red blood cells of this species are uniformly energy deficient, containing only 2% to 5% of the ATP found in the red blood cells of humans and most other mammals.[2] These cells are highly sensitive to oxidants *in vitro*, and there is now preliminary evidence that this sensitivity can be eliminated by artificially increasing intracellular ATP concentrations.

Continuing studies at UCLA are seeking to further identify a subset of black rhinoceroses that might be in jeopardy because their inherent deficiency of ATP may be compounded by an additional enzymatic defect. In the interim, it seems prudent to regard all rhinoceroses (including whites which are also ATP deficient) as though they were clinically equivalent to G-6-PD deficient humans and to protect them from drugs agents and conditions known to induce hemolysis in such subjects. These include several classes of pharmaceutical compounds (antimalarials, sulfonimides, sulfones, nitrofurans, acetanilid, chloramphenicol and some vitamin K analogues), fava beans, and a number of chemical compounds (including wood preservatives, rodent control poisons or other pesticides, strong cleansers, particularly those containing naphthalene). A large number of other drugs have been associated with hemolysis but in an uncertain or doubtful role. These include aspirin, phenacetin, aminopyrine, acetaminophen, probenecid, vitamin C, dimercaprol, p-aminosalicylic acid and L-DOPA. Additionally, in view of hemolysis induced in horses by consumption of certain oak and red maple leaves and wild onions, these should be avoided as well.

Viral, bacterial, and rickettsial infections may also induce hemolysis in G-6-PD deficient patients. In black rhinoceroses, several cases of acute hemolysis have been associated with infection with the spirochete bacterium *Leptospirosis interrogans*,

-next page-

and we are currently recommending biannual vaccination with a killed bacterin (Leptoferm-5, Norden Pharmaceuticals, Lincoln, NE, USA, it contains *L. interrogans* serovars *icterohaemorrhagiae, grippotyphosa, canicola, pomona* and *hardjo*).[3]

If you have any observations or comments, or desire further information, please contact:

Dr. Donald Paglia
Department of Surgical Pathology
Center for Health Sciences
University of California
Los Angeles, CA 90024-1732, USA
(310) 825-1614
FAX (310) 206-5178

Dr. R. Eric Miller, DVM
Veterinary Coordinator, Black Rhinoceros SSP Committee
St. Louis Zoological Park
Forest Park
St. Louis, MO 63110-1396, USA.
(314) 781-0900 ext. 277
FAX (314) 647-7969.

References

1. Luzzatto, L., A. Mehta: Glucose-6-phosphatase dehydrogenase deficiency. Chapter 91 in Metabolic Basis of Inherited Disease (6th Ed.), Scriver C.R. at. al. (Eds.), McGraw-Hill, New York, pp. 2237-2265, 1989.

2. Paglia, D.E., W.N. Valentine, R.E. Miller, M. Nakatani, R. A. Brockway: Acute intravascular hemolytic anemia in the black rhinoceros (*Diceros bicornis*) - II. Erythrocytic enzymes and intermediates. Am. J. Vet. Res. 47: 1321-1325, 1986.

3. Miller, R.E., C.A. Bolin: Evaluation of leptospirosis in black rhinoceros (*Diceros bicornis*) by microscopic agglutination and fluorescent antibody test. 1988 Proc. Am. Assoc. Zoo Vet. : 161-162, 1988.

rcSC

APR 20 [illegible]

NEW YORK ZOOLOGICAL SOCIETY

14 April 1992

R. Eric Miller, DVM
Veterinary Advisor
Rhinoceros TAG
Saint Louis Zoo
Forest Park
Saint Louis, Missouri 63110

Dear Eric,

Enclosed please find the first summary of the veterinary status of the Sumatran Rhino in the USA. I reviewed the records of the 6 animals which are presently in the states which will hopefully serve as a quick reference for the veterinarians at the participating institutions. I did not address your question of veterinary research needs- I will discuss this with the veterinarians at each holding institution at a future date. I hope this is of assistance.

Sincerely yours,

Bob

Robert A. Cook V.M.D.
Chief Veterinarian

cc:
Cinncinati Zoo- Dr. Mark Campbell
LA Zoo- Dr. Ben Gonzales
San Diego Zoo- Dr. Don Janssen

BRONX, NEW YORK [illegible] TELEPHONE [illegible] TELEX [illegible]

NEW YORK ZOOLOGICAL PARK BRONX ZOO • NEW YORK AQUARIUM • WILDLIFE CONSERVATION INTERNATIONAL
CENTRAL PARK ZOO • OSBORN LABORATORIES OF MARINE SCIENCES • ST. CATHERINES ISLAND WILDLIFE SURVIVAL CENTER

[illegible]

SUMATRAN RHINOCEROS VETERINARY UPDATE
12 APRIL 1992

Robert A. Cook, V.M.D.
Veterinary Advisor, Sumatran Rhino SSP

I. Census

At present there are 6 Sumatran rhinoceros in the United States as follows:

1.1 Cincinnati Zoo
0.1 Los Angeles Zoo
0.1 New York Zoological Park
0.2 San Diego Zoo

There are 1.1 animals in Sumatra, Indonesia at present. One or both of these animals may come to the US within the next six months.

II. Medical Record Review

A. Cincinnati Zoo

ISIS#: 189051- Mature female. "MAHATU" Arrived LA Zoo 25 Nov 88 then to Cincinnati Zoo 5 June 89. Est. birthdate 1984. Intermittent bouts of loose stool which seems to firm with removal of grain and high quality alfalfa. Numerous O+P checks, fecal cultures and cryptosporidium checks have been negative.

Dry, scaly, crusting skin over dorsum during winter treated with nolvasan solution and scrubs with brush.

ISIS#: 191091- Mature male. "IPUH". Arrived SDWAP 10 Apr 91 then to Cincinnati Zoo 25 Oct 91. No problems noted. Fecal O+P checks, and cultures negative.

B. Los Angeles Zoo

ISIS#: 0040- Young female. "KERINCI". Arrived 23 Nov 1991 No major problems. During quarantine fecal O+P negative, fecal culture=NSO.

C. New York Zoological Park

ISIS#: 901217- Mature female. "AUGUSTINE changed name to RAPUNZEL". Arrived at LA Zoo 27 Nov 89, to NYZP 16 May 90. In LA Zoo sprayed for ticks with Koral .125% Conjunctivitis Rx= Bacitracin/Neomycin/Polymixcin B. Given Leptoferm-5 vaccine. Fecal= strongyles Rx= fenbendazole, fecal exam negative for campylobacter and cryptosporidia. Loose to semi-formed stool developed shortly before trip to NYZP.

16 May 90. Arrived NYZP. Diarrhea. Fecal culture=neg, fecal acid fast stain=neg, no mycobacterium paratuberculosis isolated on culture, multiple fecal O+P negative except for amoeba sp. Rx fenbendazole SID x 3 days. Tinidazole BID x 2 days, Kaolin. None of treatments had significant effects. Dietary changes which included addition of moose pellets and decreasing of fresh browse.

3 Nov 90. Coughing during and immediately after drinking. Aerobic culture= neg. Mycobacterial cult=neg. Resolved without further incident.

D. San Diego Zoo

ISIS#: 57427- Mature Female. "BARAKAS". Arrived 26 Nov 88. Abrasions on rear foot pads. Rx=coopertox and substrate alteration. Fecal cultures negative.

15 May 91 Gore wound to left shoulder from Cincinnati male "IPUH" while he was held at SDZ. It was an 8 inch laceration with muscle visible and a discharge. Rx= Trimethoprim sulfa (Ditrim paste) orally x 7 days. Local cleansing with water and betadine BID. Withheld access to mud wallow. Resolved 13 June 91.

21 June 91. Acute onset of bilateral conjunctivitis, corneal opacities, epiphora and blepharospasm O.U. Flourscein stain negative. Conjunctival culture= <u>mycoplasma sp.</u> Rx= Ophthalmic spray, 12cc of 250mg/ml Amikacin in 988 ml 0.9% Saline (Amikacin 3mg/ml).

ISIS#: 691736- Mature female. "RAMI". Arrived 23 Nov 91. Since 3 Nov 91 treated for mammary gland penetrating wound in Indonesia with Penicillin mastitis infusion, trimethoprim-sulfa 8.2g equine paste (600lb dial dose) P.O. BID., hot packs. Also treated in Indonesia with mebendazole. Treated 26 Nov 91 with 1500 lb. dose fenbendazole paste P.O. SID x 3 days.

III. CLINICAL LAB RESULTS

A. Complete Blood Counts/ Biochemistry

	Barakas-57427/SDZ	Rami-691738/SDZ
	9 May 91	28 Jan 92
WBC	8,000	21,200
PCV	39.1	40.0
TS	7.2	7.5
Hgb	13.7	14.2
RBC	5.15	5.88
MCV	75.9	
MCH	26.6	
MCHC	35.0	
FIB	300 mg	
Plt	2.78 x 10^5	
DIFF	% (absolute)	
Segs	49(3920)	66(13992)
Lymp	34(2720)	19(4028)
Mono	8(640)	3(636)
Eos	9(720)	8(1696)
Band		4(848)
Na^+		137
K^+		5.5
Cl^-		106
CO_2		23.5
Ca^{++}		13.6
InP		4.6
AlkPho		56
SGOT		40
SGPT		7
LDH		452
CPK		1010
Gluc		112
BUN		9
Creat		1.0
U.A.		0.2
T.P.		7.8
Alb		3.3
Glob		4.5
T.Bil		0.1
Chol		71
Trig		7
Lipase		8

B. URINALYSIS

	Barakas-588440/SDZ 26 Mar 89	Rapunzel-901217/NYZP 3 Jul 90	901217/NYZP 8 Oct 90
Color	milky		Brown
Char	turbid		
S.G.	1.013(suprnat)	1.032	1.024
Sugar	Neg	Neg	Neg
Prot		Trace	Trace
Alb	Trace		
Ketone		Neg	Neg
Bile	Neg	Neg	Neg
O.Bld	Neg		
Eryt	Neg	Hemolyzed-trace	Neg
Leuk	Occasional	0-2 PHF	
pH	8.0		
Aceton	Neg		
Bact	Lrg Amt		
Casts		Lrge Granular	
Cryst		Calcium Carb(+/-)	
Comments:			+++Debris

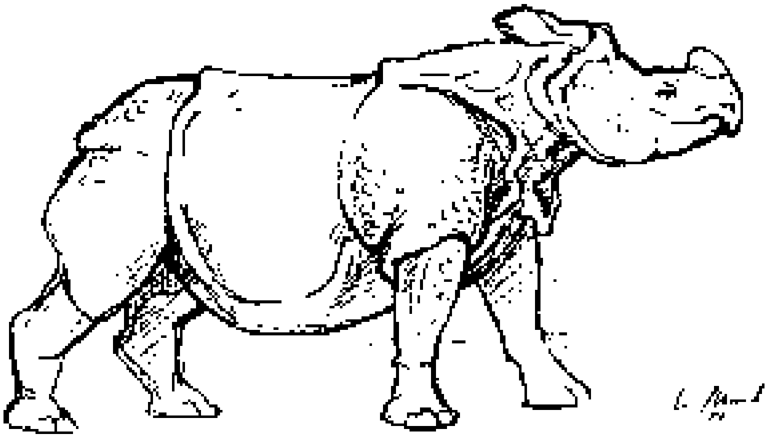
RHINO GLOBAL CAPTIVE ACTION PLAN WORKSHOP

BRIEFING BOOK

LONDON ZOOLOGICAL GARDENS
9-10 MAY 1992

SECTION 16

INDIAN/NEPALI RHINO INTERNATIONAL STUDBOOK



International Studbook
for the
Great Indian Rhinoceros
Rhinoceros Unicornis (Linné 1758)

International Studbook
for the
Great Indian Rhinoceros
Rhinoceros Unicornis (Linné 1758)

Sixth Edition, 1991
Published by the Zoological Garden Basel
(Director Dr. Dieter Rüedi)

Studbook Keeper: Kathleen Tobler

Contents

Key

Kaziranga = animals born in the Kaziranga Reservation
Assam = animals born in Assam, including the Kaziranga Reservation
Nepal = animals born in Nepal
India = animals born on the Indian subcontinent, including Nepal

The studbook number, with the exception of some belated entries, indicates the sequence of arrival in captivity, whilst the studbook name shows the name of the place where any animal was born. The letter or number following the name of the place in the studbook name indicates the sequence of capture or birth at that place.

For example: 9 Assam 3 = the 9th animal to be taken into captivity and the 3rd to be captured in Assam
29 Gauhati 2 = the 29th animal to be taken into captivity and the 2nd to be born in Gauhati

? = date uncertain or unknown
m = male
f = female
sb = stillborn
2zg = 2nd zoo-born generation

Acknowledgements

We are deeply indebted to Ernst M. Lang who compiled the data for and published the first edition of the studbook in: Breeding Endangered Species in Captivity. 293-302. R.D. Martin (ed.), London: Academic Press 1975. The support of P.J.S. Olney is gratefully acknowledged. Walter Schmid kindly granted permission to use the drawing of 'Tanaya' as the cover motif.

Our special thanks go to the holders of Indian rhinos for their cooperation. To them the studbook owes its value as a guide to the preservation of unicorns in captivity.

Distribution of Indian Rhinoceroses (31.12.90)

Antwerp	55,113,115	1.2
Basel	56,100,110,181,183	2.3
Berlin, East	40,42,168	2.1
Berlin, West	31,32,144	1.2
Bhubaneswar	153,154	1.1
Calcutta	84,85,150	2.1
Chester	132	1.0
Cincinnati	147	1.0
Cologne	97,129	1.1
Delhi	151	1.0
Dvur Kralove	86,93,145	2.1
Gauhati	168,169,170,171,172,173,174, 175,176,177,178,179	10.2
Hamburg	38,39	1.1
Hyderabad	96	1.0
Kanpur	70,122,139,140,160	4.1
Kathmandu	114	0.1
Liberec	141	1.0
Los Angeles	35,45,46	1.2
Madras	75	1.0
Miami	49,50,126	2.1
Munich	148,152	1.1
Mysore	11,61(or 24)	1.1
Nagoya	63,64	1.1
New York	53,66,67,83,87,133,181	2.5
Nuremberg	135	1.0
Oklahoma	89,125	1.1
Patna	155,156,157,159	2.2
Peking	90	0.1
Philadelphia	30,80	1.1
Rangoon	103,104	1.1
Rotterdam	234	1.0
San Diego	146	1.0
San Diego WAP	26,29,99,109,130,143,180, 182,184	4.5
San Francisco	136,137	1.1
Sao Paulo	71	1.0
Singapore	109,124,164,165	3.1
Stuttgart	34,41	1.1
Tampa	116	1.0
Tokyo	21,22	1.1
Toronto	59,79	1.1
Washington	101,138 139	1.2
Whipsnade	51,60,162	2.1
Yokohama	117,122	1.1

114 (67.47) in 43 zoos

POPULATION TREND

Year	Births	Imports	Deaths	nfs	Total
1972					31.24
1973	1.0	1.0	1.2		32.22
1974	4.0	1.2	1.0		36.24
1975	1.2	0.2	3.1		34.27
1976	3.0	0.1	2.0		35.28
1977	1.0	0.1	0.1		36.28
1978	3.2		2.0		37.30
1979	0.3	0.2	2.0		35.35
1980	3.0	3.4	3.1		41.38
1981	2.1	1.0	1.1		43.38
1982	1.5	2.0	0.2		46.41
1983	4.0	1.0	5.2		46.39
1984	3.1		0.1		49.39
1985	5.0		2.2	0.1	52.36
1986	3.5		0.4		55.37
1987	4.1	2.5	4.0		57.41
1988	4.3	1.1	3.2		59.43
1989	3.2	2.0	2.1		62.44
1990	4.2	2.1	1.0		67.47

Names and abbreviation used in the text

Amst	Amsterdam NL
Antw	Antwerp B
Assam	
Basel	Basel CH
Ber-E	Berlin, East
Ber-W	Berlin, West
Bhu	Bhubaneswar, India
Bom	Bombay, India
Brook	Brookfield Zoo, Chicago USA
Brow	Brownsville USA
Calc	Calcutta, India
Chest	Chester GB
Cin	Cincinnati USA
Colo	Cologne D
Delhi	Delhi, India
DvKr	Dvur Kralove CS
Gauh	Gauhati, India
Gels	Gelsenkirchen D
Hamb	Hamburg D
Hou	Houston USA
Hyde	Hyderabad, India
India	
Kan	Kanpur, India
Kat	Katmandu, Nepal
Kaz	Kaziranga Reserve
Lib	Liberec CS
LosAn	Los Angeles USA
Luck	Lucknow, India
Madr	Madras, India
Mag	Magdeburg D
Miami	Miami USA
Milw	Milwaukee USA
Mun	Munich D
Myso	Mysore, India
Nago	Nagoya, Japan
Nepal	

NeYo	Bronx Zoo, New York USA
Nur	Nuremberg D
Okla	Oklahoma USA
Omah	Omaha USA
Paris	Paris F
Patna	Patna, India
Peki	Peking, China
Phil	Philadelphia USA
Rang	Rangoon, Burma
Rome	Rome I
Rott	Rotterdam NL
StLou	St Louis USA
SD	San Diego USA
SDWAP	San Diego Wild Animal Park USA
Safr	San Francisco USA
SaPau	Sao Paulo, Brasil
Seoul	Seoul, Korea
Sing	Singapore
Stutt	Stuttgart D
Tam	Tampa USA
Tokyo	Tokyo, Japan
Toro	Toronto, Canada
Triv	Trivandrum, India
Wash	Washington USA
Whip	Whipsnade GB
Yoko	Yokohama, Japan

Transport

Removal by force from the known to the unknown must rouse great fear in every animal. Man, himself, is no exception. And as it is he who is responsible for transporting the animals referred to here, he should contrive means of lessening their anxiety. Moreover, this is in the interests of both buyer and seller.

The following do's and don'ts are offered as guidelines. At the same time we are aware that none of them is new to you.

Arrange for transports to be made during the cooler seasons!

Choose a crate strong enough to contain the animal! At Basle solid wood reinforced with iron is used. Horizontal air slits are left between the boards forming the sides and top of the crate.

The Indian rhino requires a crate made to measure. Make it just wide enough for the animal to lie down but not to turn round! In length it should also be fairly close-fitting to prevent the animal from pacing back and forth and charging with its horn.

It is often advocated that the animal should be accustomed to the crate by feeding it there regularly for some weeks prior to transport. None the less, despite habituation, a tense situation will arise once the crate is shut and begins to move.

At Basle the rhino walks through a passage, just wide enough to admit it, towards a crate which is securely fixed at the exit. Once it has entered the passage, a door is closed behind it to prevent escape. The rhino is then coaxed into the crate which is closed by a door sliding down from the top.

Indian rhinos are usually given valium. Under sedation they are more tractable but tend to be less resistant to stress situations.

Work quietly and unhurriedly!

One attendant, who is trusted by the animal, will offer it reassurance and also accompany it to its destination. As far as possible do not leave the animal unattended!

On arrival the attendant should introduce the animal to its new quarters. He will describe to the new owners the regimen used hitherto and ask them to observe it until the animal has completely settled down.

RHINO GLOBAL CAPTIVE ACTION PLAN WORKSHOP

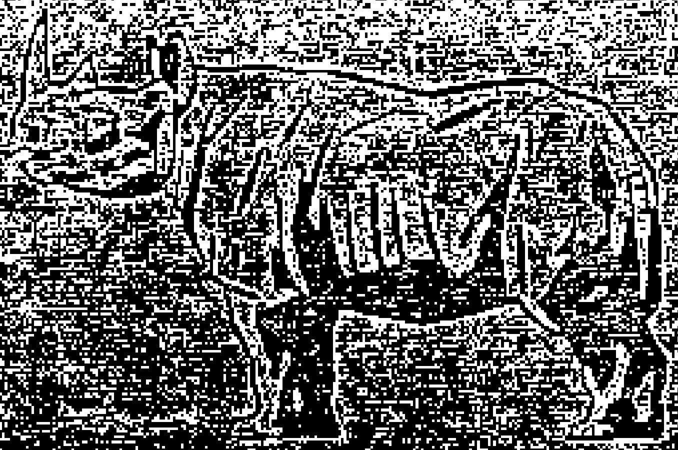
BRIEFING BOOK

LONDON ZOOLOGICAL GARDENS
9-10 MAY 1992

SECTION 17

AFRICAN RHINO INTERNATIONAL STUDBOOK

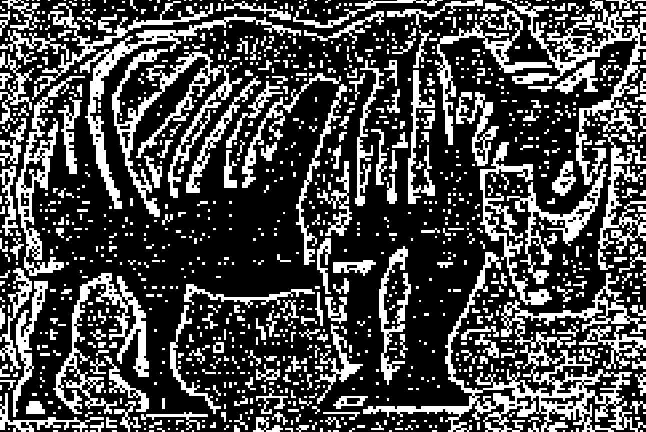
ZOOLOGISCHER GARTEN BERLIN



INTERNATIONALES ZUCHTBUCH FÜR AFRIKANISCHE NASHÖRNER

4

INTERNATIONAL STUDBOOK FOR AFRICAN RHINOCEROSES



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INHALT / CONTENT

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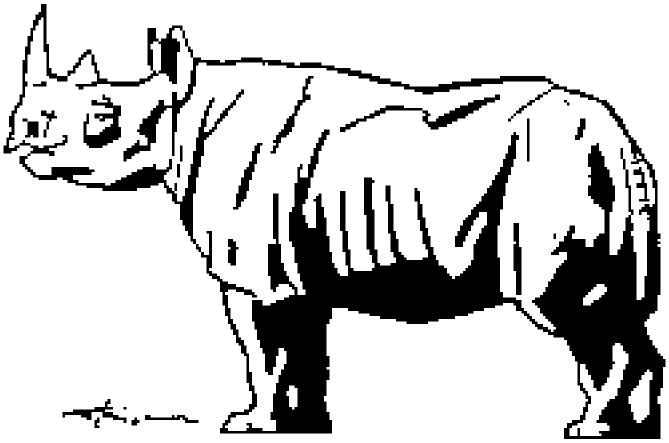
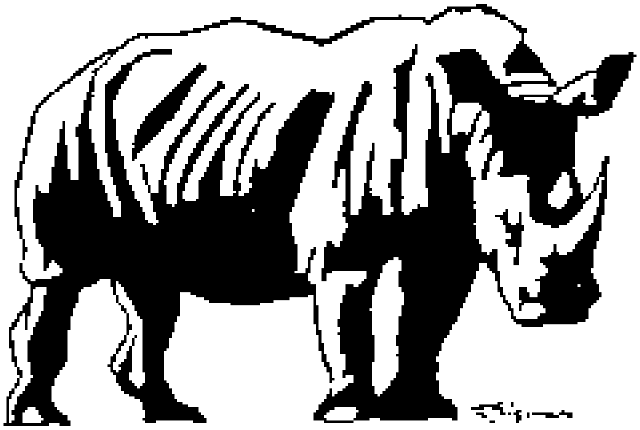
ZOOLOGISCHER GARTEN BERLIN

INTERNATIONALES ZUCHTBUCH FÜR AFRIKANISCHE NASHÖRNER
(Diceros bicornis/Ceratotherium simum)

INTERNATIONAL STUDBOOK FOR AFRICAN RHINOCEROSES
(Diceros bicornis/Ceratotherium simum)

Nr.4





1.1.1991

Nr. 4

INTERNATIONALES ZUCHTBUCH FÜR AFRIKANISCHE NASHÖRNER
(*Diceros bicornis*/*Ceratotherium simum*)

Herausgegeben vom

ZOOLOGISCHEN GARTEN BERLIN

Direktor Prof. Dr. Dr. h. c. Heinz-Georg Klös

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Bearbeitungsstand: 31. 12. 1990
ISSN 0724-9748

No 4

INTERNATIONAL STUDBOOK OF AFRICAN RHINOCEROSES
(*Diceros bicornis*/*Ceratotherium simum*)

Published by

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Director Prof. Dr. Dr. h. c. Heinz-Georg Klös

Studbook Keeper and EEP-Coordinator

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Dead line: 31. 12. 1990
ISSN 0724-9748

DRINGENDER APPELL AN ALLE HALTER VON AFRIKANISCHEN NASHÖRNERN

Die Qualität eines Zuchtbuches hängt überwiegend von der Vollständigkeit der beim Zuchtbuchführer eingehenden Informationen ab!

Die 1979 in Kopenhagen verfaßten und in Warschau von der IUDZG angenommenen Richtlinien zur Führung der Zuchtbücher können vom Zuchtbuchführer nur dann eingehalten werden, wenn die betreffenden Haltungen mindestens einmal jährlich (spätestens bis zum 10. Januar) Bestandsveränderungen bzw. -bestätigungen vollständig - bei Todesfällen mit Angabe der primären Todesursache! - melden! Die Bearbeitung der Daten auch wegen eventueller Rückfragen ist jedoch wesentlich einfacher, wenn Bestandsveränderungen unverzüglich mitgeteilt werden!

Der Zuchtbuchführer registriert alle Tiere, auch Aborte, Totgeburten und Jungtiere, die gleich nach der Geburt gestorben sind! Solche Individuen erhalten auch eine Zuchtbuchkarte bzw. Zuchtbuchnummer, jedoch verbleibt die Karte beim Zuchtbuchführer.

Bei Todesfällen sind die entsprechenden Zuchtbuchkarten dem Zuchtbuchführer baldmöglichst zurückzusenden.

Werden Individuen an den Tierhandel abgegeben, sind die entsprechenden Zuchtbuchkarten grundsätzlich an den Zuchtbuchführer zu übersenden, der sie an den neuen Halter weiterreicht. Händler sind zu verpflichten, dem Zuchtbuchführer unverzüglich den neuen Halter zu nennen!

Bei Zuchtleihgaben begleitet die Zuchtbuchkarte das betreffende Tier. Der neue Halter hat dem Zuchtbuchführer den Tod des Tieres oder aus der Zuchtgemeinschaft resultierende Geburten zu melden.

Zwecks eindeutiger Identifizierung registrierter Tiere müssen Meldungen immer das Geburtsdatum, Geschlecht und die Zuchtbuchnummer beinhalten. Es reichen keineswegs die Angaben von Hausnamen oder bei Benutzung von ISIS die ISIS-Nummern!

DER ZUCHTBUCHFÜHRER

URGENT APPEAL TO ALL INSTITUTIONS KEEPING AFRICAN RHINOCEROSES

The good quality of the studbook greatly depends on detailed reports submitted by rhino keeping institutions to the studbook keeper!

The report of the Copenhagen Conference of 1979 - ratified by the IUDZG in Warsaw - lists the essential data which should be collected in studbooks.
These directions can only be met by the studbook keeper if complete and detailed updates are sent to him annually (but no later than 10th January) by all institutions concerned. Updates should state all changes having occured during the reporting period or indicate that no changes are to be reported. Death reports sent to the studbook keeper must include not only date of death but also primary cause of death of animal.
To ensure enough time for checkbacks and to reduce problems altogether it is adviseable to submit status-report each time change occurs.

Registered are all births including: abortions, stillbirths, and life born animals that do not survive! Such animals are registered and issued studbook cards, which remain on file.

The studbook card of a registered individual that has died must be returned to the studbook keeper.

The studbook card of animals being removed from site via animal dealer should always be sent back to the studbook keeper who in turn will forward it to the receiving institution. This, however, requires that dealers are being committed to send note to the studbook keeper stating the animal's new location.

The studbook card of animals sent away on loan should be forwarded to recipient of animal. The death of an animal on loan assignment should immediately be reported to the studbook keeper by that institution; this also applies to young who are descendent from parent on loan assignment.

Change in status reports on individuals already registered should for unmistakeable identification always include: date of birth, sex, and studbook number.
Non-sufficient is to only state house-name and/or ISIS number.

STUDBOOK KEEPER

VORWORT

Obwohl für 1990 angekündigt, erscheint das INTERNATIONALE ZUCHTBUCH FÜR AFRIKANISCHE NASHÖRNER um ein Jahr verspätet. Grund hierfür sind die für Deutschland und insbesondere Berlin umwälzenden Ereignisse des geschichtsträchtigen Jahres 1990, die aufgrund der Grenzöffnung zum Osten Europas auch den Zoologischen Garten Berlin in Atem gehalten haben. Nicht nur das schlagartige Anwachsen des Besucherstromes von etwa 3.5 auf 4 Millionen und die damit verbundene gewaltige Mehrarbeit aller Mitarbeiter, sondern auch die vielen Besuche und Kontaktaufnahmen der bisher von Berlin gewaltsam ferngehaltenen Kolleginnen und Kollegen aus verschiedenen osteuropäischen Ländern und dem Osten Deutschlands verlangten von den wissenschaftlichen Mitarbeitern so viel intensive Aufmerksamkeit, daß ein Teil der Arbeit zunächst einmal liegenbleiben mußte. Wir bitten daher um Verständnis, daß auch die internationalen Zuchtbücher erst heute vorliegen.

PREFACE

Publication of the 4th edition of the INTERNATIONAL STUDBOOK OF THE AFRICAN RHINOCEROSES was originally planned for 1990. The delay by one year is due to the revolutionary political changes in Germany and above all in Berlin. 1990 will go down in history as the year of reunification of the two postwar German states and the opening of the wall toward East Europe.
This sensational event also kept Berlin Zoo people in constant excitement. The enormous rise of number of visitors from about 3.5 to 4 Million people as well as the numerous visits of colleagues from all over East Europe and the former GDR asked for an extraordinary engagement of our scientific staff, leading to an additional work-load that could hardly be managed. Much of the planned work therefore had to be postponed.

We therefore ask your kind understanding that the International Studbook of the African Rhinoceroses is only presented today.

EINFÜHRUNG zur 4. überarbeiteten Ausgabe des Internationalen Zuchtbuches für afrikanische Nashörner

---

Die rapide Abnahme der Spitzmaulnashornbestände in freier Wildbahn konnte bis heute nicht gestoppt werden. In der 3. Ausgabe (1987) des Internationalen Zuchtbuches für afrikanische Nashörner berichteten wir über den zur Situation dieser vor ihrer Ausrottung stehenden Großsäuger 1986 veranstalteten Workshop unserer in der AAZPA zusammengeschlossenen nordamerikanischen Kollegen. Zum Zeitpunkt dieser Arbeitssitzung internationaler Fachleute wurde der Bestand an Spitzmaulnashörnern in freier Wildbahn auf ca. 4000 Individuen geschätzt. Seitdem wurde mit nationaler und internationaler Unterstützung der Schutz der Spitzmaulnashornpopulationen enorm verstärkt. Je besser jedoch die Wildhüter zur Wahrnehmung ihrer Aufgaben mit Waffen und sogar Fluggerät ausgerüstet wurden, desto besser wurde auch die Bewaffnung und Mobilität der Wilderer. Dennoch konnte erfreulicherweise in den letzten Jahren das Absinken der Bestandszahlen verlangsamt werden. Heute dürfte die Kopfzahl der Spitzmaulnashorn-Population auf etwa 3000 Tiere zurückgegangen sein. Während 1970 noch der Anteil der östlichen Unterart *Diceros b. michaeli* weit überwog, wird heute der Anteil der südlichen Unterart *Diceros b. minor* mit etwa 2000 Tieren beziffert (Brooks, 1989) und stellt nun ca. zwei Drittel des Gesamtbestandes.

Die Situation der südlichen Unterart der Breitmaulnashörner *Ceratotherium s. simum* ist weiterhin stabil. Der Bestand in freier Wildbahn zählt zur Zeit etwa 4000 Tiere. Dies ist den sehr erfolgreichen Bemühungen des Wildschutzes der Republik Südafrika und Zimbabwes zu verdanken. In diesen beiden Staaten scheint auch das Überleben der dortigen Spitzmaulnashorn-Populationen gesichert zu sein.

Die Kopfzahl der nördlichen Unterart des Breitmaulnashorns *Ceratotherium s. cottoni* ist erschreckend gering. Sie soll laut Rocco (1990) 26 Tiere betragen. Ermutigend ist die Geburt von 4 Individuen im Jahre 1989 im Garamba Nationalpark (Zaire), dem letzten Refugium von Ceratotherium s. cottoni. Dies ist eine äußerst schmale Basis für eine Überlebenschance dieser Unterart. Noch schlechter sieht die Situation in Zoologischen Gärten aus, wo nur 12 (5.7) Individuen gehalten werden, davon 10 (3.7) in Dvur Kralové, CSFR.

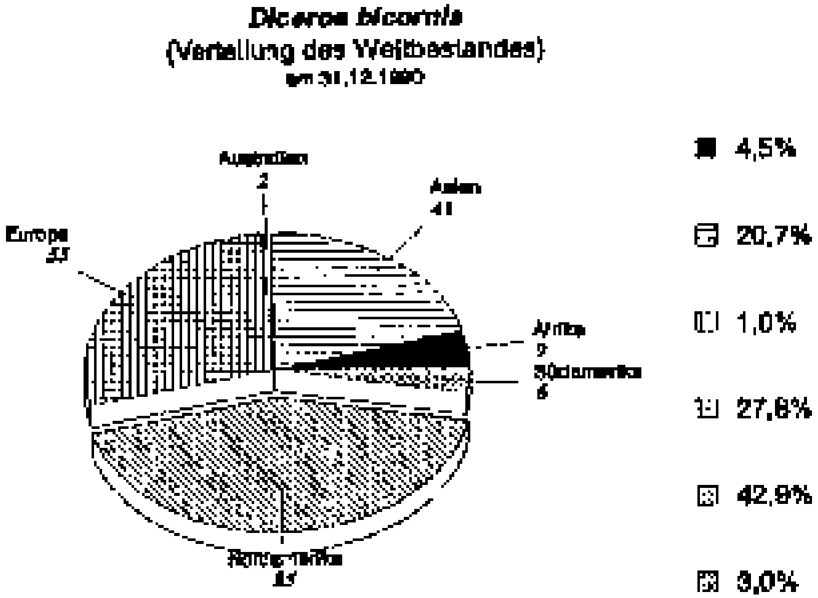
1) Bericht zur Situation des Spitzmaulnashornbestandes in Menschenhand

Zum 31.12.1990 verzeichnete das Zuchtbuch 204 (91,113) lebende Individuen in 73 Haltungen. In den Jahren 1987 bis 1990 wurden 24 (10,14) Tiere der Unterart *Diceros b. michaeli* und 6 (2,4) Individuen der Unterart *Diceros b. minor* geboren und 10 (4,6) Wildfänge der Unterart *Diceros b. minor* aus Zimbabwe in Zoologische Gärten der USA und ein Paar nach Frankfurt/Main importiert. Der Import nach Nordamerika wurde von der CBSG (CAPTIVE BREEDING SPECIALIST GROUP), einer Sektion der Internationalen Naturschutzbehörde (IUCN) empfohlen und ausgearbeitet. Ziel dieser Aktion ist, die weltweiten

Bemühungen des internationalen Schutzes für das Spitzmaulnashorn auf zwei Beine zu stellen: zum einen das gezielte Bestandsmanagment in freier Wildbahn und zum anderen den Aufbau einer Bestandsbasis im Rahmen eines koordinierten Erhaltungszuchtprogrammes (SSP) der Zoologischen Gärten. Dies ist für die betroffene Spitzmaulnashornunterart von eminenter Bedeutung, da bisher nur 34 (10.14) Individuen in Menschenhand gehalten werden. Auch die Arbeit der im Europäischen Erhaltungszuchtprogramm (EEP) koordinierten Zoologischen Gärten Kontinentaleuropas zeitigte aufgrund gezielten Managements und entsprechenden Tausch von männlichen Individuen gute Zuchterfolge, wie z. B. in den Zoos von Berlin, Dvur Kralové und Zürich.

Zwischen 1987 und 1990 starben 26 (14,12) Spitzmaulnashörner. Das erreichte Durchschnittsalter dieser Tiere betrug 18 1/2 Jahre (Das erreichte Höchstalter betrug 36 Jahre). 7 Tiere starben im 1. Lebensjahr.

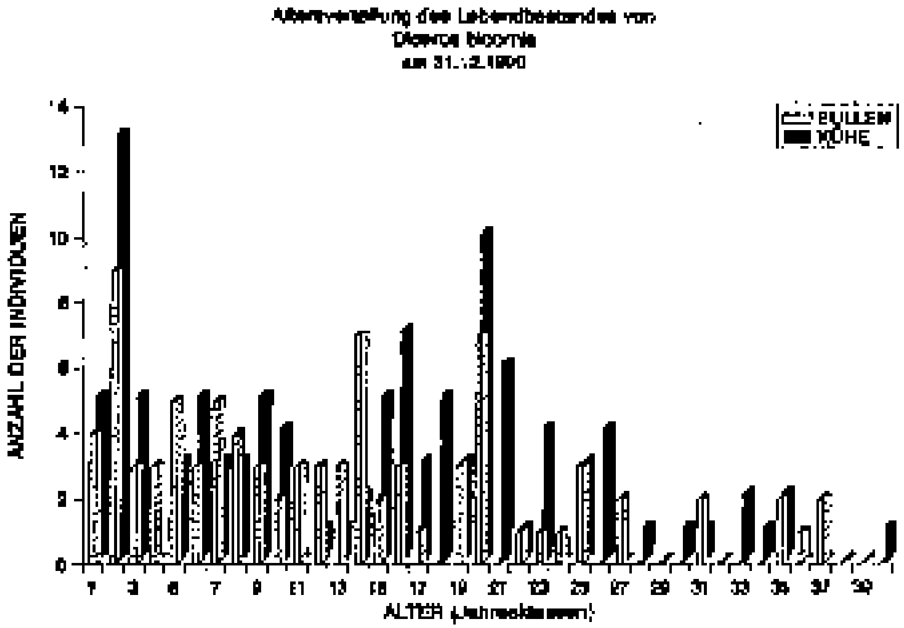
Abb. 1



Die oben angeführte Grafik zeigt den Weltbestand an Spitzmaulnashörnern aufgegliedert nach Kontinenten. Sie macht deutlich, daß der nordamerikanische Kontinent mit 85 Tieren deutlich dominiert. Zugenommen hat der Bestand in Asien. Dies ist vor allem auf die Bemühungen japanischer Zoologischer Gärten zurückzuführen. Die europäische Population hat sich aufgrund guter Zuchterfolge in den letzten Jahren stabilisiert.

Die Tiere der Weltpopulation befinden sich überwiegend im Alter von 1 bis 20 Jahren, nur etwa 10% der Population sind älter. Ein Weibchen hat das Alter von 40 Jahren erreicht. Gut die Hälfte aller Spitzmaulnashörner ist im zuchtreifen Alter. (Abb. 2)

Abb. 2



Der Großteil des nordamerikanischen Bestandes ist jünger als 20 Jahre. Auffallend ist der hohe Anteil an Tieren unter 5 Jahren. (Abb. 3)

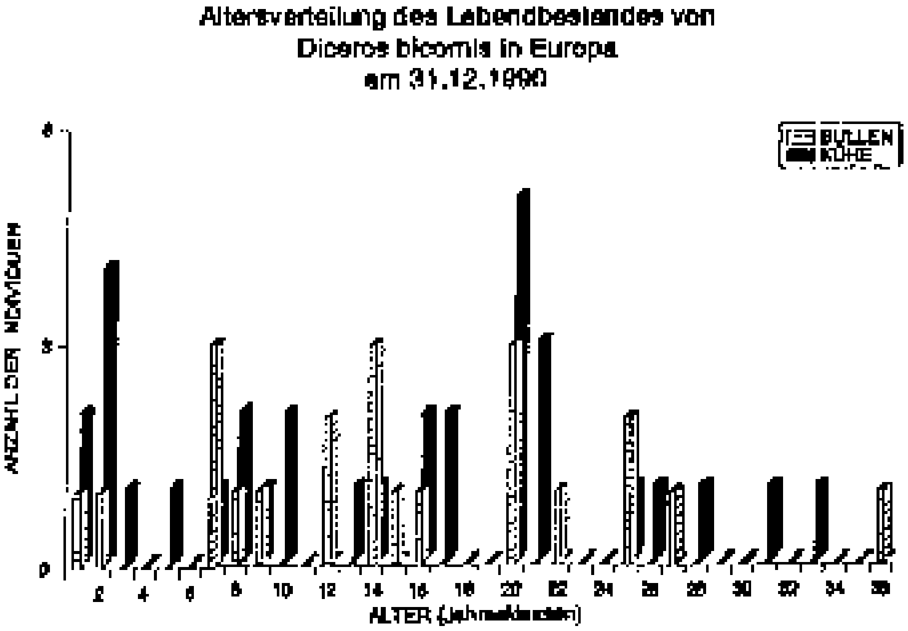
In Europa ist der Durchschnitt der Individuen älter, der Anteil von Jungtieren unter 5 Jahren ist erheblich geringer. Hier droht eine Überalterung des Bestandes. (Abb. 4)

Die Altersklassen des asiatischen Bestandes sind ausgeglichen repräsentiert. (Abb. 5)

Abb. 3

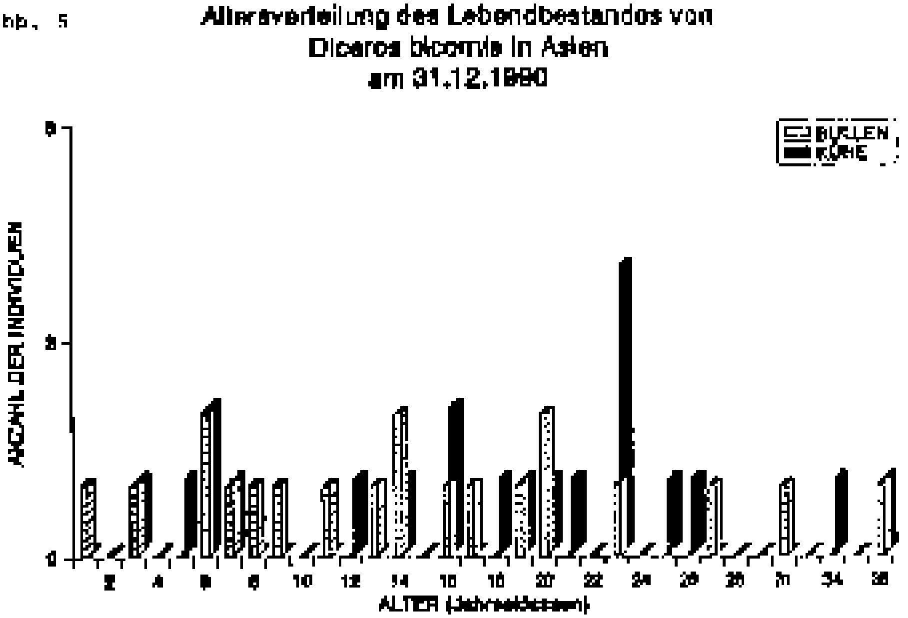
Altersverteilung des Lebendbestandes von Diceros bicornis in Nordamerika am 31.12.1990

Abb. 4



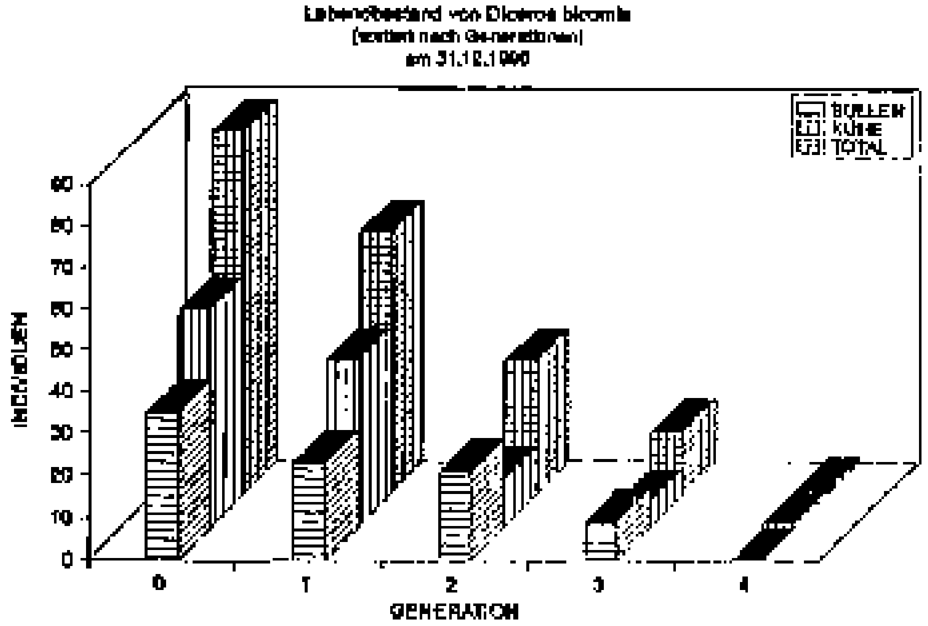
Altersverteilung des Lebendbestandes von Diceros bicornis in Europa am 31.12.1990

Abb. 5



Altersverteilung des Lebendbestandes von Diceros bicornis in Asien am 31.12.1990

Abb. 6



Lebendbestand von Diceros bicornis (sortiert nach Generationen) am 31.12.1990

Ungefähr 40% des Spitzmaulnashorn-Weltbestandes umfaßt der freien Wildbahn entnommene Individuen und gehört somit noch der Foundergeneration an, etwa 30% der Population der 1. Generation, etwa 15% der 2. Generation und die restlichen Individuen der 3. Generation. Ein weiblicher Bastard (Diceros b. michaeli x Diceros b. minor) in der nordamerikanischen Haltung Linn repräsentiert die 4. Generation. (Abb. 6)

Die monatliche Geburtenverteilung zeigt weltweit einen saisonalen Anstieg der Geburtenrate zur zweiten Jahreshälfte. Dies ist sicherlich darauf rückzuführen, daß ein Großteil der Institutionen aus witterungsbedingten Gründen Spitzmaulnashörner überwiegend in den Frühjahrs- bzw. Sommermonaten verpaaren. (Abb. 7)

Die Altersverteilung der gestorbenen Individuen weist einen erschreckend hohen Anteil an Spitzmaulnashörnern aus, die im Alter bis zu 4 Jahren gestorben sind. Innerhalb dieser Altersgruppe weisen bis zu 2 Jahre alte Jungtiere die höchste Sterblichkeitsrate auf. Etwa 60% der Individuen starben im Alter bis zu 20 Jahren, weitere etwa 30% im Alter von 20 bis 30 Jahren, der restliche Anteil im Alter von über 30 Jahren. (Abb. 8)

Im Bereich der nordamerikanischen Haltungen sind die Verluste an Jungtieren in der Altersklasse 0 bis 4 Jahre in etwa gleich verteilt (Abb. 9). Im europäischen Raum dagegen ist ein deutlicher Abfall der Verlustkurve innerhalb der genannten Altersklasse festzustellen (Abb. 10). Aufgrund der geringeren Reproduktionsrate in der asiatischen Region sind die Altersklassen etwa gleich repräsentiert, die Häufung von Jungtierverlusten ist nicht herausragend (Abb. 11).

Abb. 7

Diceros bicornis
(Geburtenverteilung über die Monate)

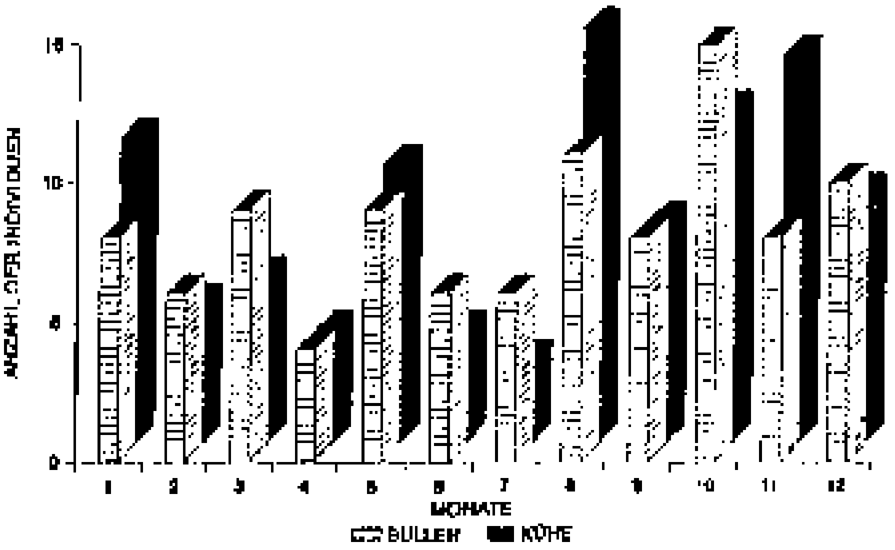


Abb. 8

Diceros bicornis
(Altersverteilung der toten Individuen)
1956 - 1991

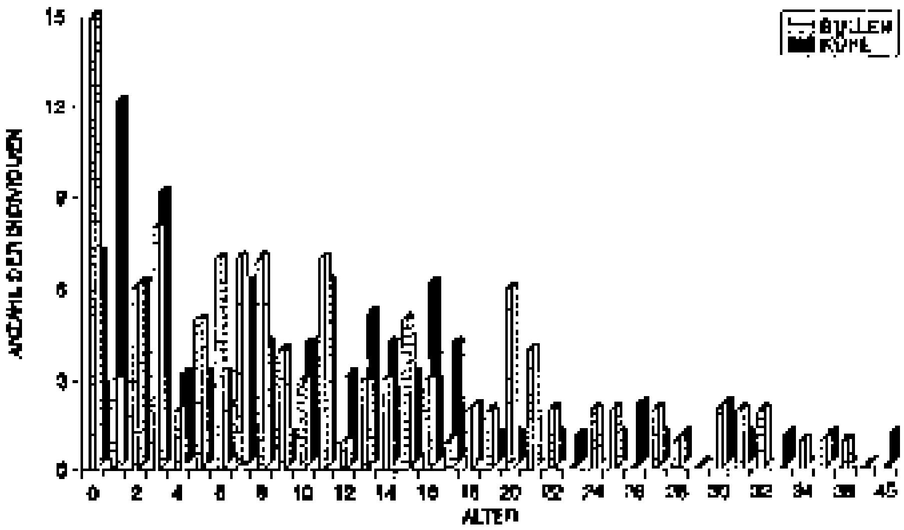


Abb. 9

Diceros bicornis
(Altersverteilung der toten Individuen
in Nordamerika , 1956 - 1990)

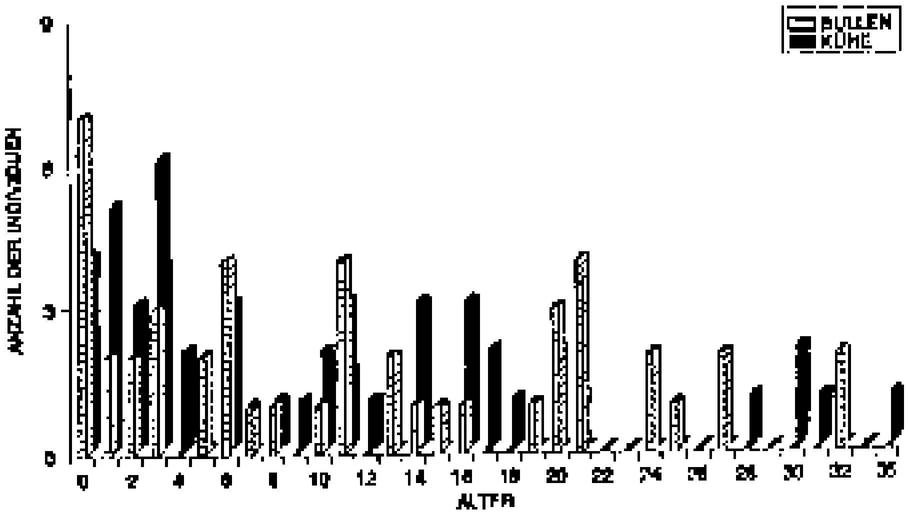


Abb. 10

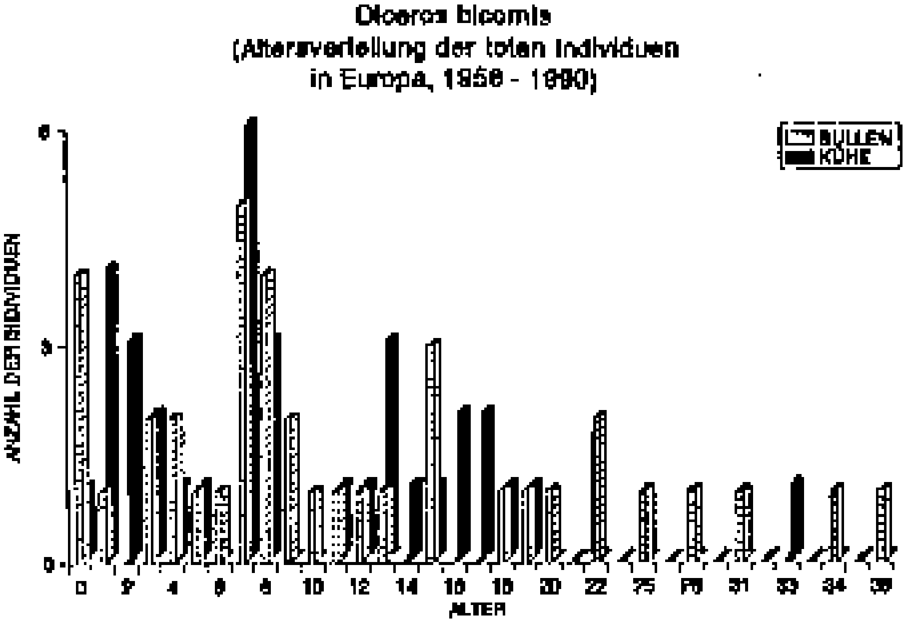
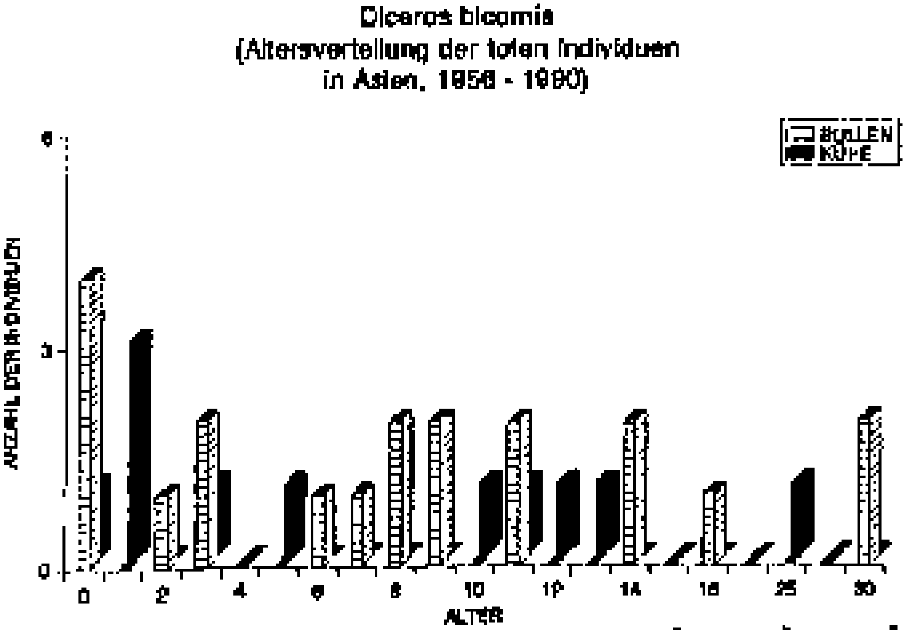


Abb. 11



Die Betrachtung der saisonalen Verteilung der weltweiten Todesfälle zeigt eine leichte Häufung von Dezember bis April (Abb. 12). Dies scheint im Einklang zu stehen mit den Erkenntnissen der Ernährungsphysiologie. Besonders in der kalten Jahreszeit, wenn die auf Blattnahrung spezialisierten Tiere nur wenig Frischfutter zu sich nehmen können, traten aufgrund von Vitaminmangel (insbesondere der Vitamine A, C und E) schwerwiegende Erkrankungen auf. Die Mangelerscheinungen sind zum Teil durch Gabe von hochvitaminisierten Pressfutter zu vermeiden. Hierzu laufen in Zoologischen Gärten der USA und Europa intensive Untersuchungen.

In der nordamerikanischen Region ist die saisonale Abhängigkeit der Todesfälle ausgeprägter (Abb. 13). Bei den weiblichen Individuen finden wir eine relativ geringe Sterblichkeitsrate in der warmen Jahreszeit, wohingegen von Dezember bis Mai die Häufung der Todesfälle herausragt. Die Todesfälle bei den Nashornbullen häufen sich deutlich im Dezember und Januar und im Frühjahr bzw. Sommer.

Die saisonale Verteilung der Todesfälle im europäischen Raum weist eine gegenläufige Tendenz auf (Abb. 14). Es fällt auf, daß in den Monaten Juni bis September bei beiden Geschlechtern kaum Todesfälle auftraten. In den übrigen Monaten ist eine beinahe gleichbleibende Häufung der Todesfälle zu beobachten.

Der Jahresverlauf der Todesraten beider Geschlechter in den Haltungen der asiatischen Region ist gekennzeichnet durch eine deutliche Häufung in den Monaten Januar und Februar sowie sehr geringe Raten in den Monaten März bis Juni.

Abb. 12

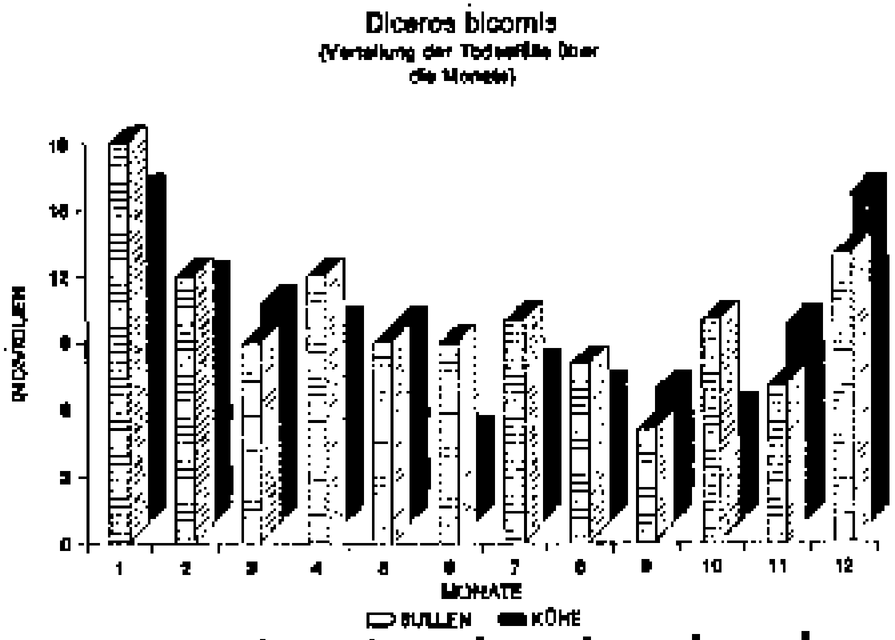
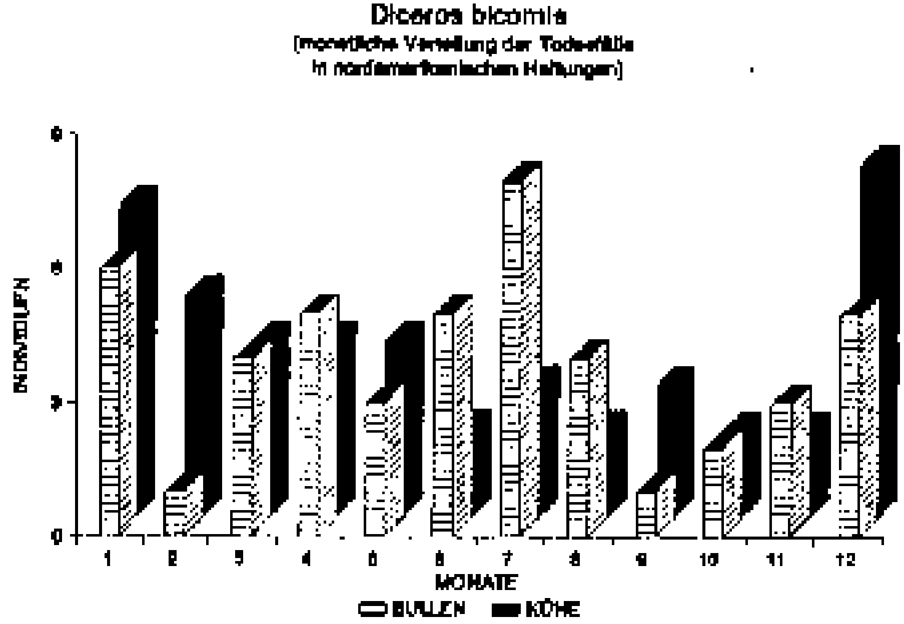


Abb. 13



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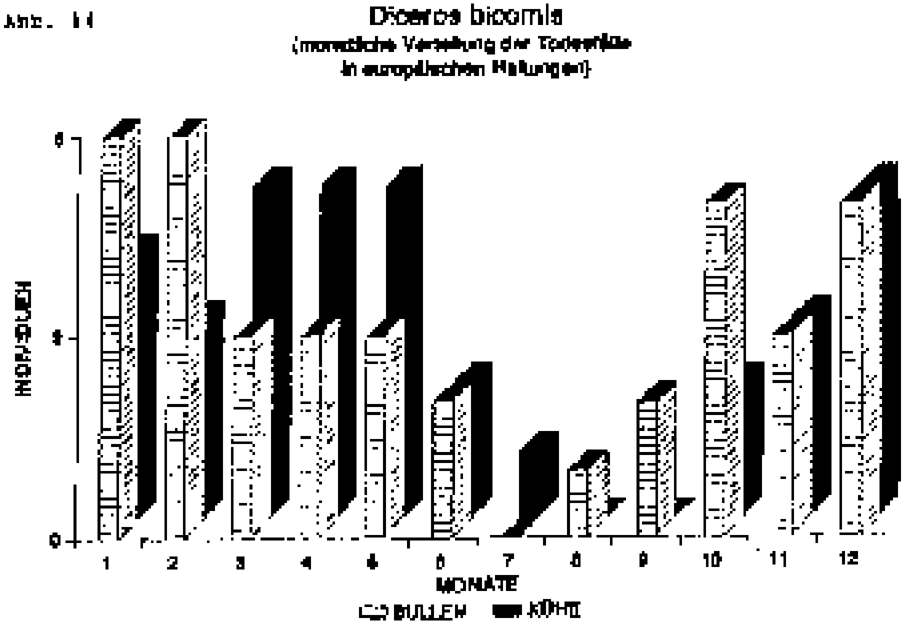


Die Entwicklung des in Menschenhand gehaltenen Spitzmaulnashornbestandes hat sich seit 1987 wesentlich günstiger entwickelt als noch in der Einführung zur 3. Ausgabe des Internationalen Zuchtbuches für Afrikanische Nashörner (1987) berichtet. Allerdings wird das Bild aufgrund der Importe aus freier Wildbahn verfälscht. Rechnet man diese 12 Individuen ab, so beträgt der effektive Zuwachs der Population seit 1986 nur 17 Tiere. Dennoch ist dies nach Jahren rückläufiger bzw. stagnierender Entwicklungen ein sehr erfreulicher Zuwachs. Besonders günstig sieht die Bestandsentwicklung im nordamerikanischen Raum aus, zumal hier auch der Anteil an subadulten Tieren besonders hoch ist. Auch in Europa sieht das Bild aufgrund des Geburtenschubs in den vergangenen Jahren ermutigend aus. Sicherlich ist diese positive Entwicklung zu einem Großteil dem intensiven Management der regionalen Erhaltungszuchtprogramme zuzuschreiben.

Für die Zuchtbuchführung bewirken die regionalen Zuchtprogramme zudem eine erfreuliche Kooperation mit den betroffenen Haltungen.

3) Bericht zur Situation des Breitmaulnashornbestandes in Menschenhand

Zum 31.12.1990 belief sich der Bestand an Breitmaulnashörnern auf 709 (346.362.1) Individuen in 245 Haltungen. In den Berichtsjahren wurden 45 (24.20.1) Individuen geboren, davon ein Weibchen der nördlichen Unterart *Ceratotherium s. cottoni* in Dvur Kralové. Es starben 31 (11.20) Tiere, davon der zu der nördlichen Unterart gehörende Bulle Nr. 19 (Loh 1) im Alter von ca. 40 Jahren. 7 Individuen überlebten das 2. Lebensjahr nicht. Das für den Berichtszeitraum höchste Alter erreichte ein weiblicher Wildfang in Pretoria (Nr. 58) mit 41 Jahren.
(Am 29.01.1991 starb der nördliche (*cottoni*) Bulle Nr. 71/ STL 1 im Alter von etwa 36 bis 37 Jahren.)

Der Weltbestand an Breitmaulnashörnern in Menschenhand ist über alle Kontinente gestreut. Die weitaus meisten Tiere (345) werden in Europa gehalten, die nordamerikanische Region folgt mit 193 Individuen und der asiatische Raum mit 131 Breitmaulnashörnern (Abb. 15)

Der Bestand an Tieren der Unterart *Ceratotherium s. cottoni* konzentriert sich mit 3.7 Individuen auf den Zoo in Dvur Kralové, CSFR. 2 Bullen im Alter von 18 bzw. 34 Jahren werden im San Diego Wild Animal Park gehalten.

Die Altersstruktur der Population spiegelt die Importwelle in den 70iger Jahren wieder (Abb. 16). Auffällig ist jedoch der Rückgang der Geburtenrate in den vergangenen 2 Jahren. Hier muß darauf hingewiesen werden, daß im nächsten Jahrzehnt das Gros der Importtiere (etwa 250 Individuen!) altersbedingt sterben wird! Der Verlust eines Drittels des jetzigen Bestandes wird bis dahin kaum durch Nachzuchten gedeckt sein.

Abb. 15

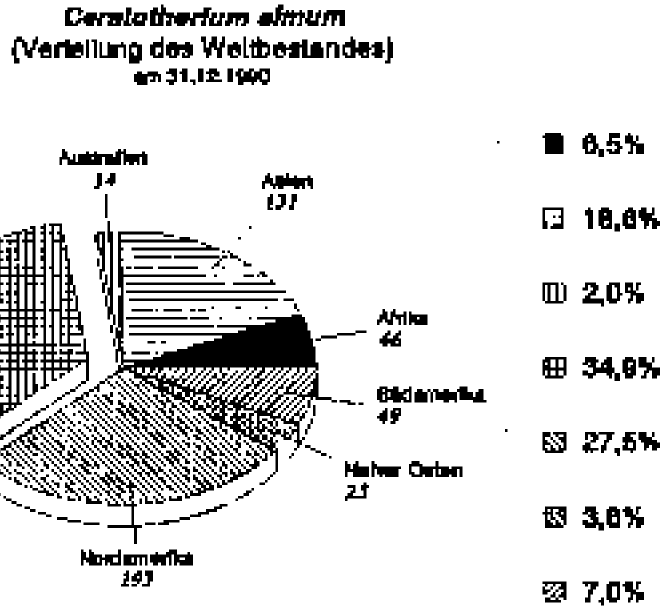
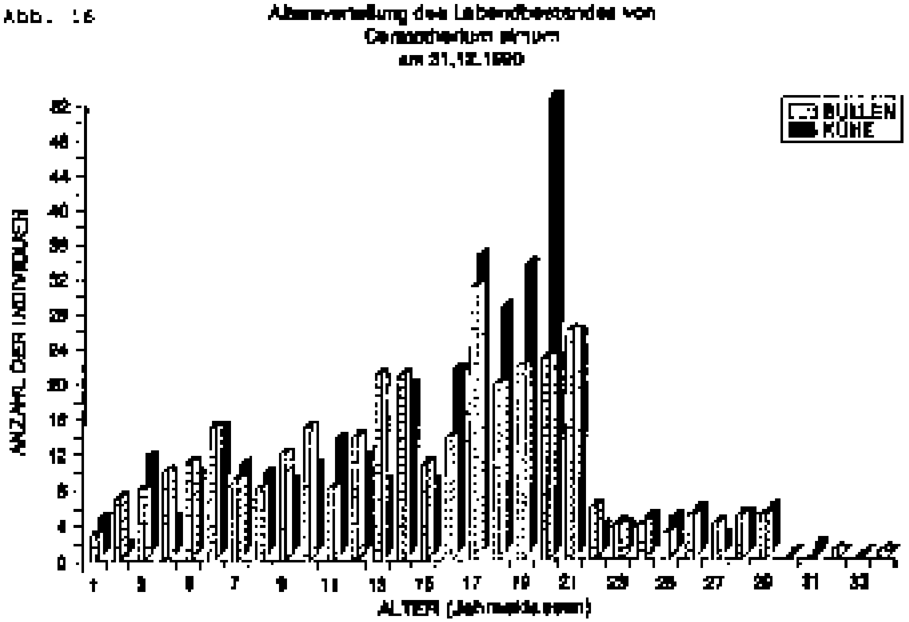


Abb. 16



Etwa die Hälfte der Population besteht aus Nachwuchstieren der 1. Generation, nur 21 Individuen entstammen der 2. Generation (Abb. 17).

Abb. 17

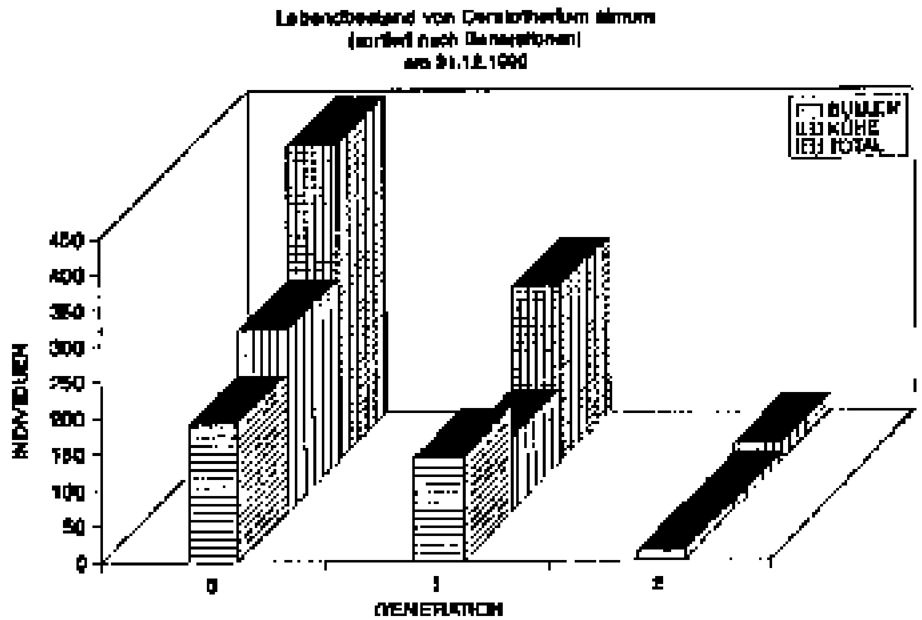
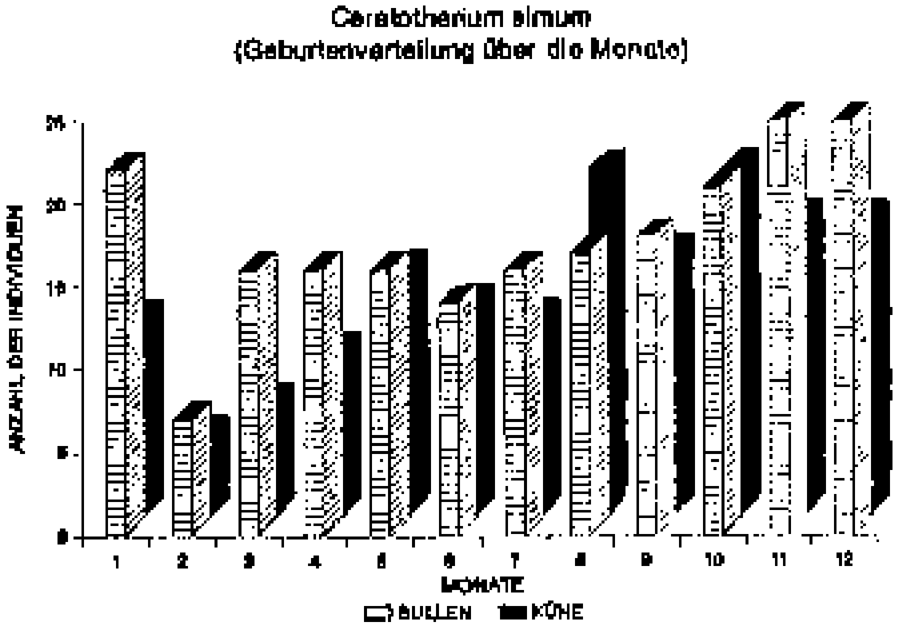
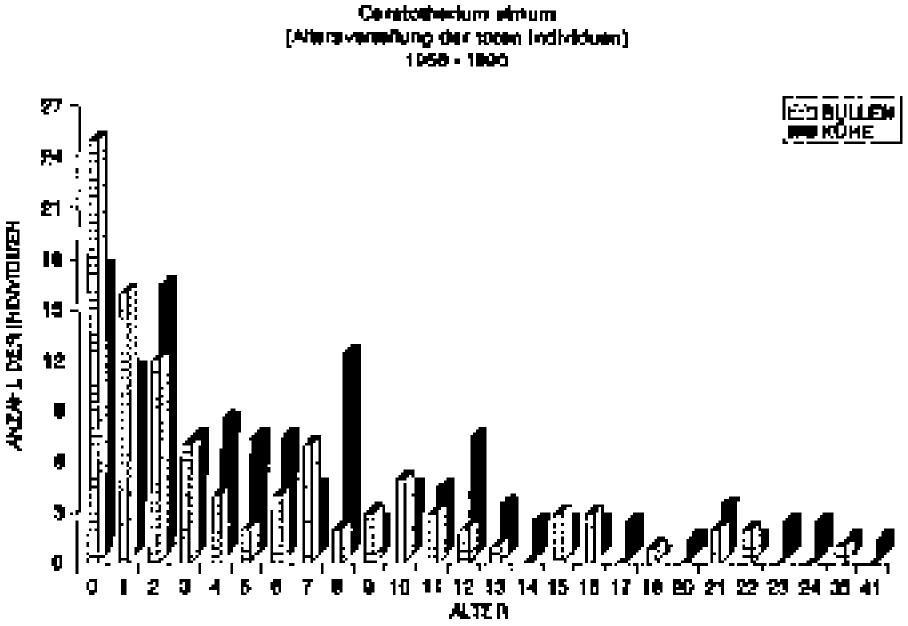


Abb. 18



Die saisonale Abhängigkeit der Geburtenrate zeigt einen deutlichen Abfall im Februar und eine steigende Tendenz vom Frühjahr bis in den Herbst hinein. Der Höhepunkt umfaßt die Monate November bis Januar. (Abb. 18)

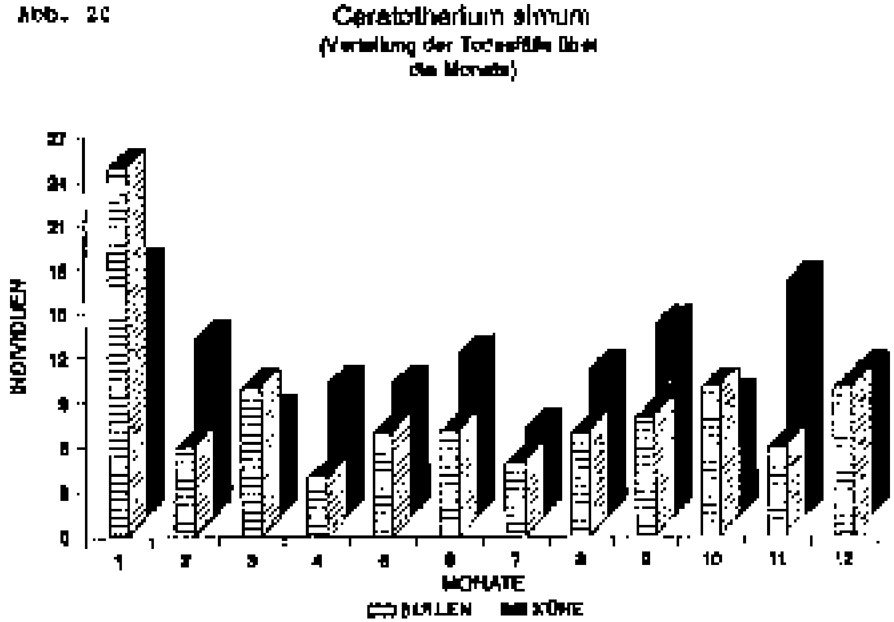
Abb. 19



Die Todesfälle konzentrieren sich auf die subadulten Breitmaulnashörner, insbesondere auf die bis zu 2 jährigen Jungtiere. Im ersten Lebensjahr starben die meisten der Jungtiere, wobei die Bullen deutlich überwogen. Einen unerwartet hohen Anteil an Verlusten weisen 8 jährige Weibchen auf. Das Höchstalter erreichte eine Breitmaulnashornkuh mit 41 Jahren. (Abb. 19)

Die saisonale Abhängigkeit der Todesfälle weist einen deutlichen Höhepunkt im Januar auf, die restlichen Monate lassen keinen eindeutigen Trend erkennen. (Abb. 20)

Abb. 20



Probleme bei der Bearbeitung der Breitmaulnashorndaten bereiten dem Zuchtbuchführer einige in den USA tätige Tierhändler. Hier ist an erster Stelle der Händler EARL TATUM zu nennen. Dieser ist trotz vieler drängender Anfragen zu keiner Kooperation bereit. Somit ist dem Zuchtbuchführer der derzeitige Haltungsort einiger Breitmaulnashörner unbekannt. Das Problem ist den amerikanischen Kollegen bekannt, desto verwunderlicher ist es, daß der AAZPA angehörende Haltungen nach wie vor Nashorntransfers über diesen Händler abwickeln. Der Zuchtbuchführer wendet sich deshalb erneut an das Präsidium der AAZPA, auf Earl Tatum nachdrücklich einzuwirken, damit eine vernünftige Kooperation mit dem Zuchtbuchführer wie mit anderen Händlern auch gewährleistet wird. In den letzten Jahren hat auch die Kooperationsbereitschaft von INTERNATIONAL ANIMAL EXCHANGE (IAE) wieder sehr nachgelassen!

Literatur:

BROOKS, P. M. (1989): Proposed conservation plan for the black rhinoceros *Diceros bicornis* in South Africa, the TBVC states and Namibia. Koedoe 32/2, 1 - 30

REECE, R. W. (1990): Encouraging news from Zaire. The Rhino conservation newsletter Vol. 1, No 2, page 4

Berlin, im Januar 1991

Heinz-Georg Klös
Reinhard Frese

INTRODUCTION to the 4th revised edition of the International Studbook of African Rhinoceroses

The drastic decline of black rhinoceroses in the wild to this date could not be brought to a halt.

In the 3rd edition (1987) of the INTERNATIONAL STUDBOOK OF AFRICAN RHINOCEROSES the international studbook keeper reports on the critical situation of this large mammal in the wild.
October 1985 an African Rhino Workshop was initiated and carried out by AAZPA - union of all North American zoospecialists. In 1986 estimated population of black rhino on the African continent totalled 4,000 animals. More effective protection of the species was demanded on a national and international basis. However, the better armed gamewardens became and the more flying personnel was mobilized the better armed and the more mobile poachers became.

The decline could however, be slowed down in the past years. Till today the black rhino population was reduced to 3,000. Until 1970 the eastern black rhino subspecies *Diceros b. michaeli* predominated in number, today the southern subspecies *Diceros b. minor* is represented by about 2,000 individuals (BROOKS, 1989), totalling approximately one third of the entire population.

Due to actions taken by the authorities of the Republic of South Africa and Zimbabwe the situation of the southern white rhino subspecies remains stable. Its present status in the wild is about 3,500 animals. The black rhino population in that region also seems secured.

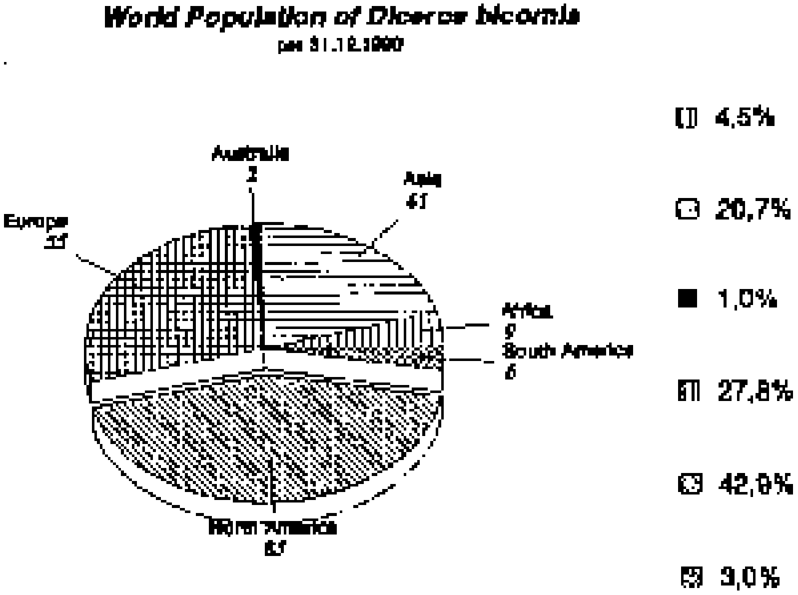
Dangerously small is the population of the northern white rhino subspecies *Ceratotherium s. cottoni*. REECE (1990) reports of 26 individuals - too small a basis for survival! However, encouraging are 4 births reported from Garamba National Park (Zaire) 1989 - last stronghold of *Ceratotherium s. cottoni*.
The situation for the captive *Ceratotherium s. cottoni* population is worse still: only 12 (5.7) animals live in zoos, 10 (3.7) of which in Dvur Kralove Zoo, CSFR.

1. GENERAL POPULATION TREND OF BLACK RHINOCEROSES IN CAPTIVITY

Captive live population of black rhino as of 31.12.1990 is 204 (91.113) animals in 73 locations.
Between 1987 and 1990 there were 34 (15.19) births of *Diceros b. michaeli* and 6 (2.4) births of *Diceros b. minor*. 10 (4.6) Diceros b. minor were acquired from Zimbabwe by zoos in the USA and 1.1 by Frankfurt/M Zoo, Germany. The importation to Northamerica was recommended and arranged for by the CBSG - CAPTIVE BREEDING SPECIALIST GROUP - a section of the International Union for Conservation of Nature (IUCN).
Goal of the transfer was to open two alternatives to international black rhino conservationists:
1. planned management of the population in situ
2. set up of population within the Species Survival Program (SSP) of zoological gardens.

For the survival of the black rhino subspecies this initiative is of enormous importance since today only 24 (10.14) animals live in captivity.
Conservation efforts of European zoos - co-ordinated in the Continental European Survival Program (EEP) - were rewarded with rather good breeding results in Berlin, Zurich and Dvur Kralove and may be attributed to planned management of population and planned transfer of breeding males. Between 1987 and 1990 there were 26 (14.12) black rhino deaths, average age being 18,5 years (maximum age 36 years). Seven animals died under the age of 1 year.

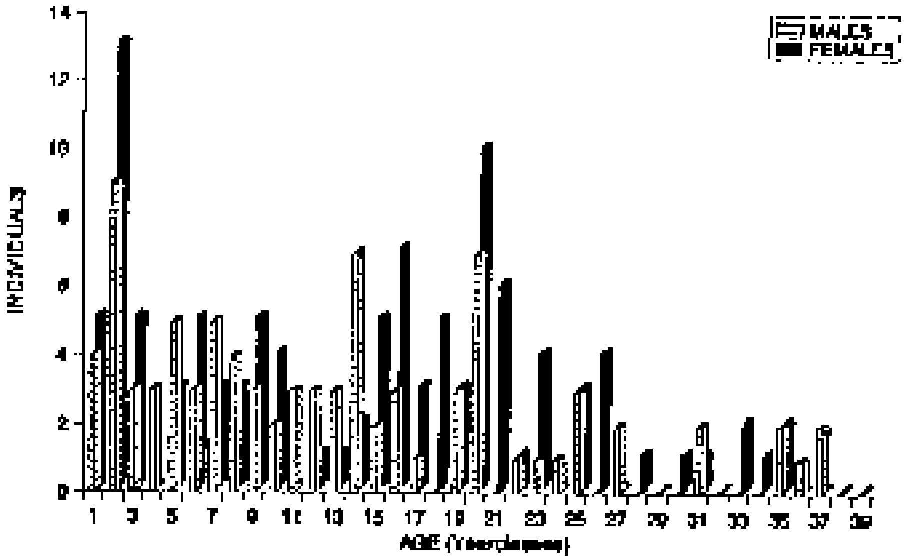
Figure 1



Above live black rhino world population (by continents) shows that North America takes precedence of all other continents with 85 animals.
Population increase in Asia may be attributed to the remarkable engagement of Japanese zoos. The European population became stabilized due to good breeding results.
Age-structure of the world live population average between 1 to 26. Only about 10 % of the population is older than that. One female is 40 years old. More than half the black rhino population is of breeding age (figure 2).

Figure 2

Age Distribution of Diceros bicornis (living population) per 31.12.1991



A large number of the North American live population is under 20 years of age. Noticeable is the large number of individuals under 5 (figure 3).

Individuals kept in Europe are older on an average. Less individuals in Europe are under 5, indicating a rise in ratio of old individuals to total population (figure 4).

Age-structure of Asian populations is quite balanced (figure 5).

Figure 3

Age Distribution of Diceros bicornis (living population of Northamerica) per 31.12.1990

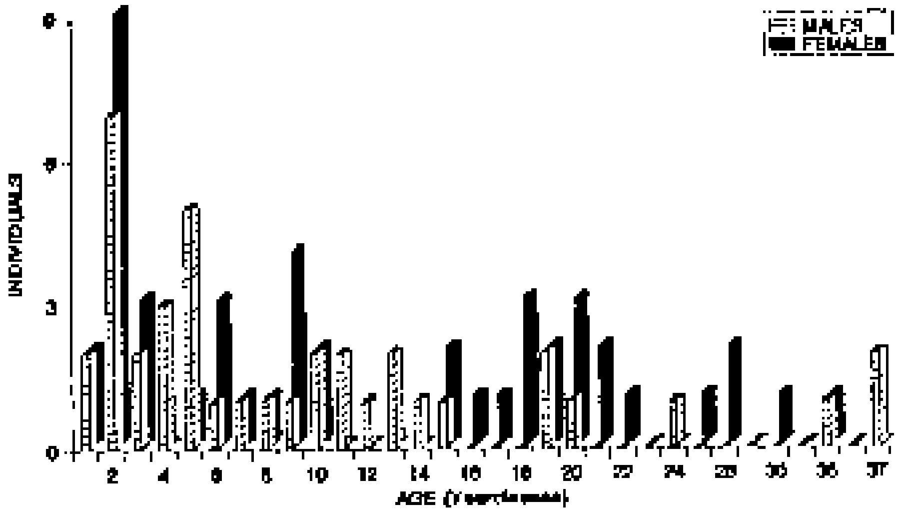


Figure 4

Age Distribution of Diceros bicornis (living population of Europe) per 31.12.1990

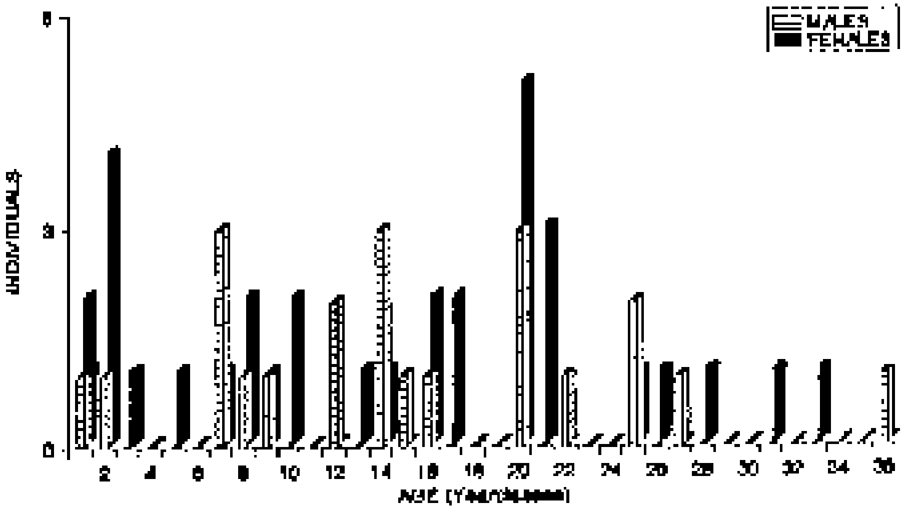


Figure 5

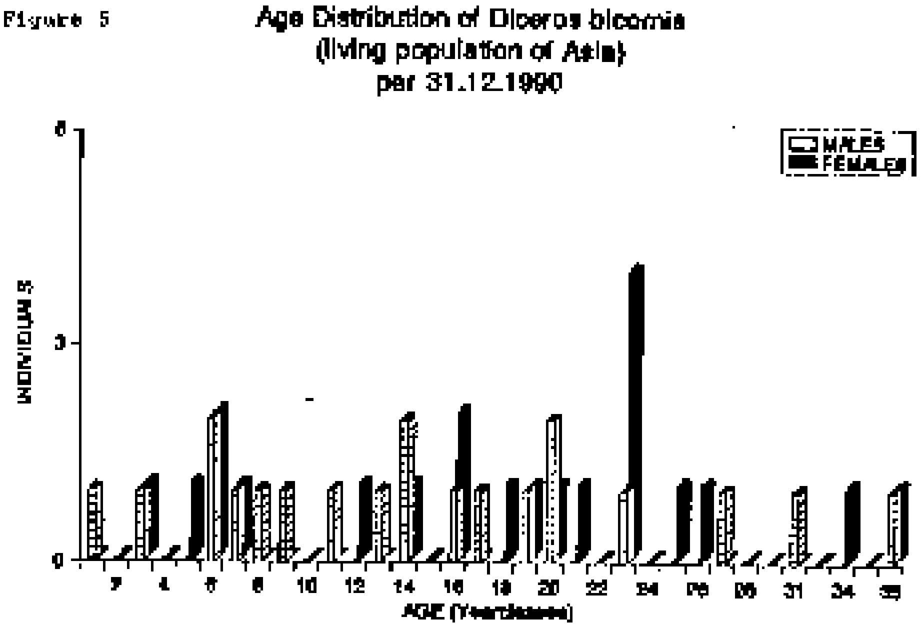
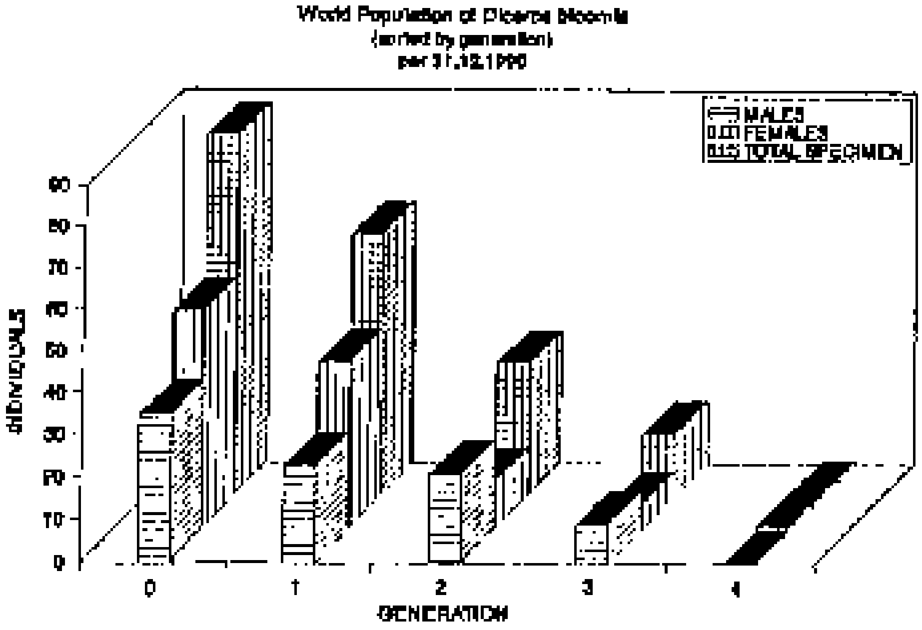


Figure 6



About 40 % of the captive live black rhino world population belong to the wild born founder generation; 30 % are 1st generation, and appr. 15 % 2nd generation. All other are 3rd generation animals.
One female cross breed (*Diceros b. michaeli* x *Diceros b. minor*) in Linn, North America, represents 4th generation (figure 6).
World-wide birth-rate by months shows an increase in the second half-year, which may be due to the fact that institutions mate their animals in spring and summer (figure 7).
Figure 8 (age-structure of dead population) clearly reveals an enormously high death-rate in black rhino under 4 years of age. Highest death-rate is found in animals under 2.

About 60 % of the total dead population died under 20 years of age, 30 % died between 20 and 30; all other lived to be older than 30 (figure 8).
In North America losses are even in young black rhino between 0 to 4 (figure 9).

In Europe less losses occur within the same age-group (figure 10).

Due to low reproduction age-structure of black rhino population in Asia is more less even. Here losses of young individuals represent no significance (figure 11).

Figure 7

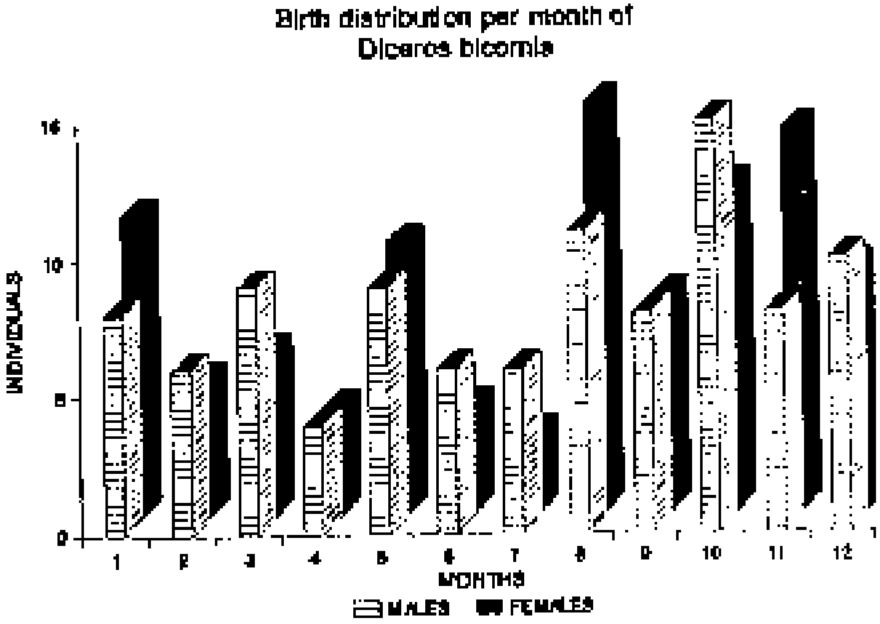


Figure 8

Age of Diceros bicornis
(World population, dead animals)
1958 - 1990

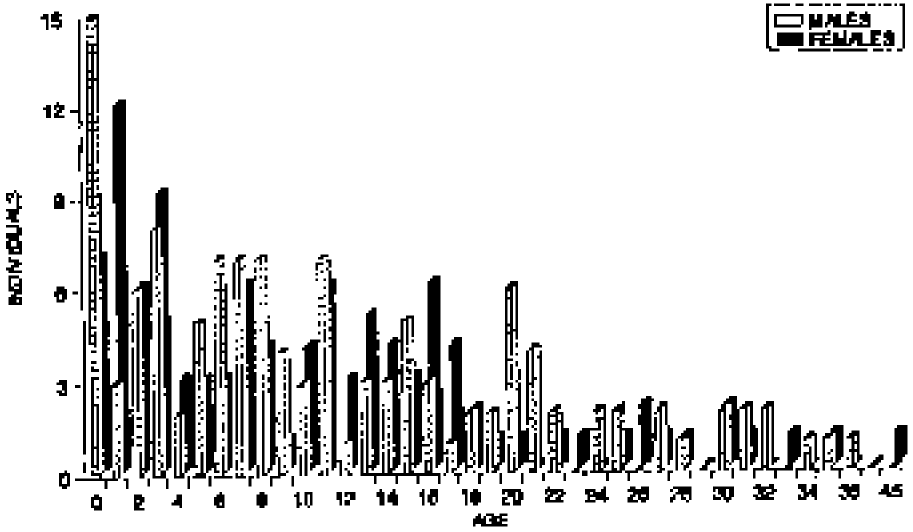


Figure 9

Age of Diceros bicornis
(Northamerica, dead animals)
1958 - 1990

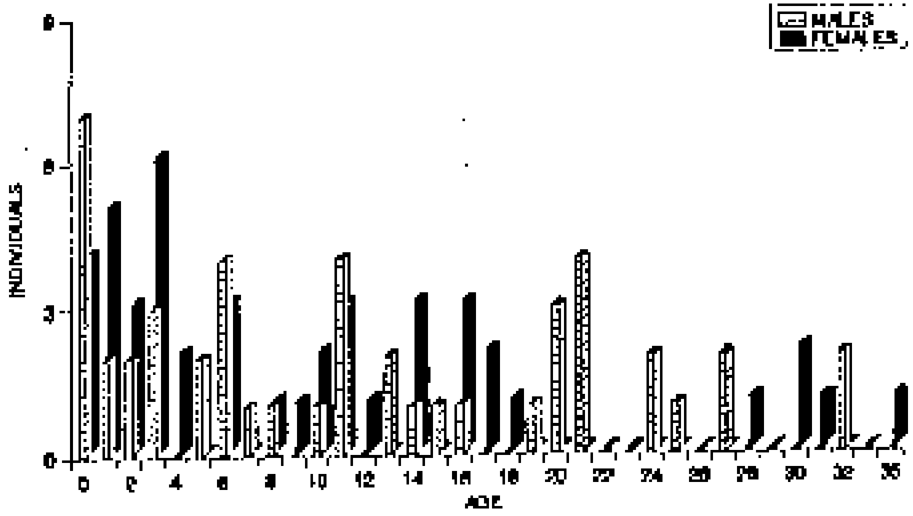


Figure 10

Age of Diceros bicornis
(Europe, dead animals)
1958 - 1990

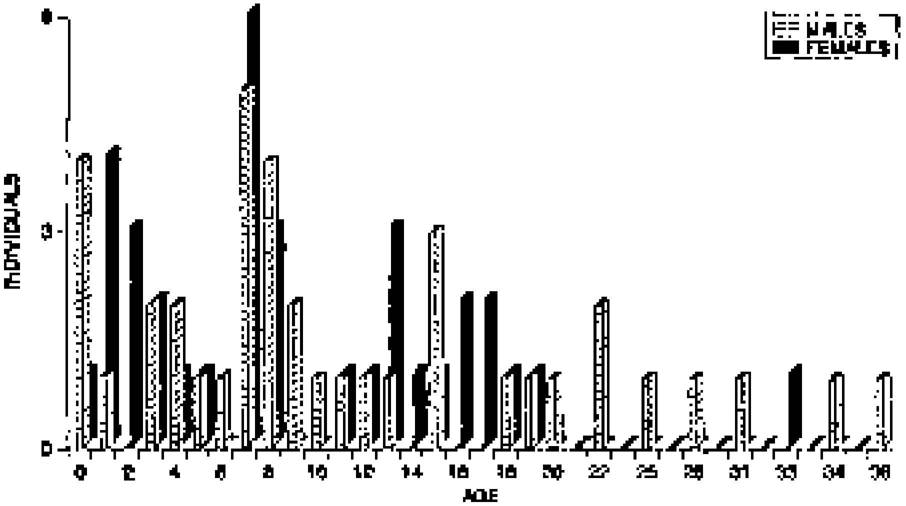
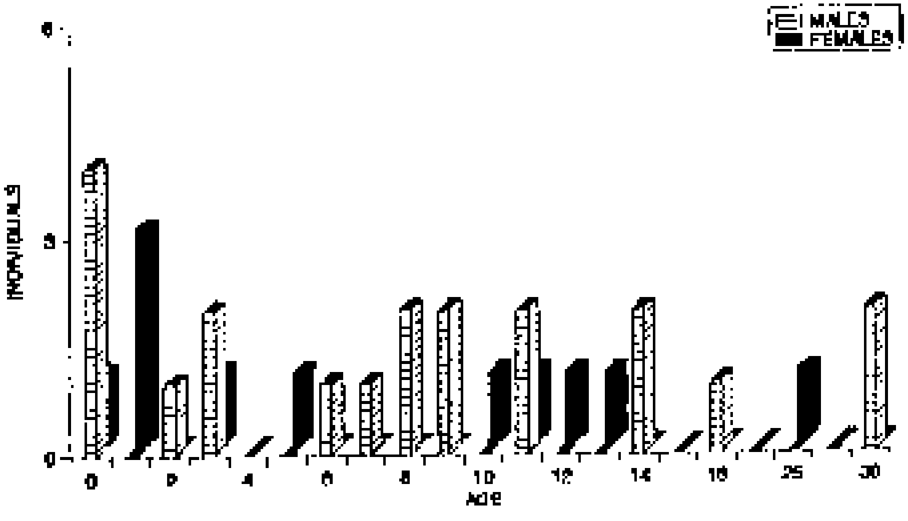


Figure 11

Age of Diceros bicornis
(Asia, dead animals)
1958 - 1990



A slight but obvious rise of deaths can be noted world-wide between December and April (Figure 12) which does concur with diet studies.

Since during the winter months fresh greenstuff is not available, fatal disorders may occur due to vitamin deficiencies mainly of the vitamin A, C, and E. To prevent such fatalities vitamin fortified feed supplements should be added to the diet. Research is being done in that field in US and European zoos.

In North America rhino deaths are more dependent on seasons than any other region (figure 13). Very few females die in summer, whereas from December through May the death-rate skyrockets. Male death-rate rises in December and January and in spring and summer.

Between June and September death-rate drops to a very low in both sexes in the European population and rises again, though in an even manner, throughout the rest of the year (figure 14).

In Asia the peak of deaths is reached in both sexes in January and February. Between March and June death-rate drops to an extreme low.

Figure 12

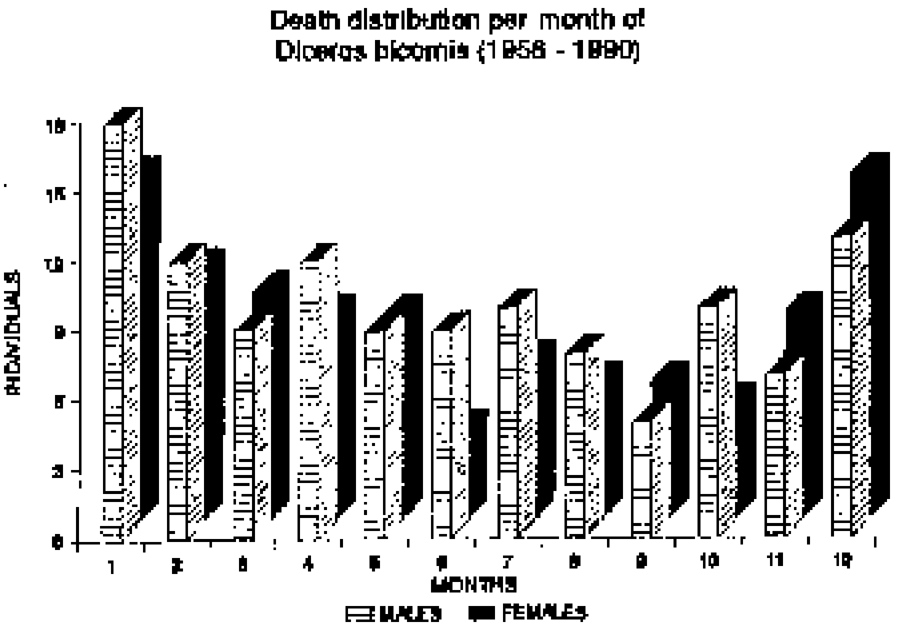


Figure 13

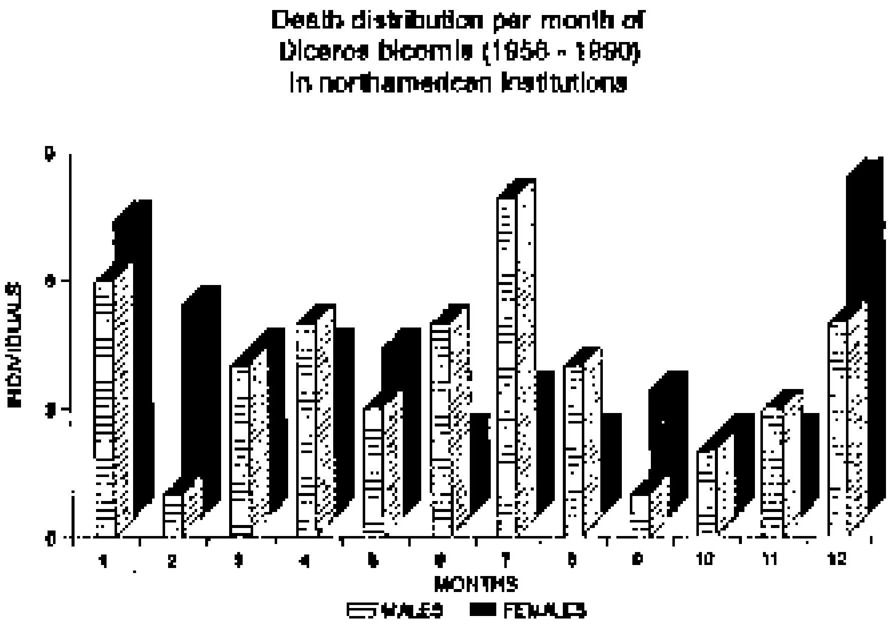
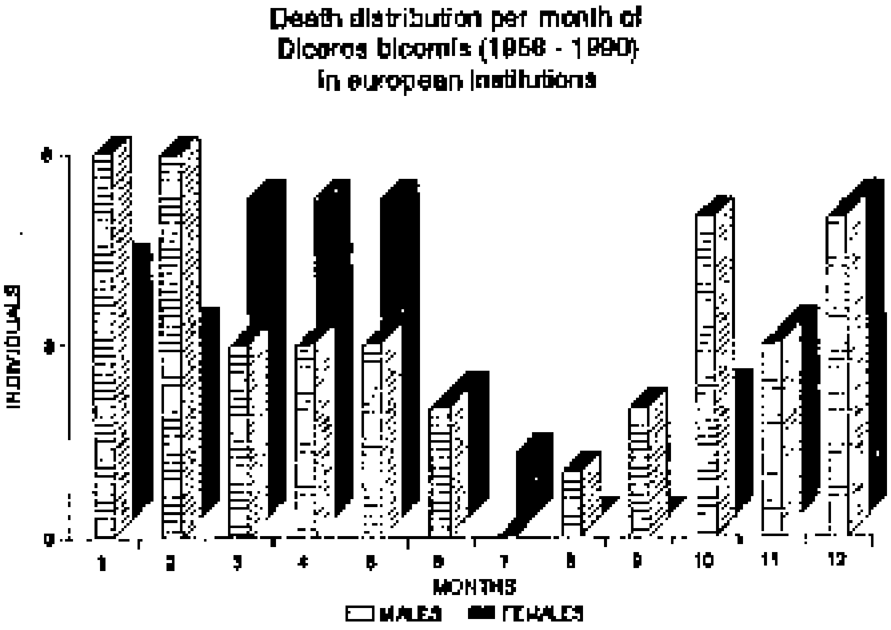


Figure 14



Population trend of captive black rhino is much more positive since 1987 than was expected (ref. 3rd edition of the International Studbook of African Rhinoceroses, 1987). 12 animals came from the wild, distorting this positive picture somewhat. The actual population increase by births is 17 animals since 1986.

The numerical increase of black rhino - although small - may give reason for hope, especially if one looks back at the steady decline of population respectively stagnation of births of recent years.

A rather positive situation can be noticed in North America where an especially high number of subadult individuals live. The positive population trend in Europe is due to good breeding results, which may be attributed to planned species management under the direction of the European Survival Program (EEP).
Since the installation of regional survival projects cooperation between the international studbook keeper and institutions keeping the species has improved considerably.

3. GENERAL POPULATION TREND OF WHITE RHINOCEROSES IN CAPTIVITY

Captive live population of white rhino as of 31.12.1990 is 709 (346.362.1) animals in 215 locations.
During the reporting period there were 45 (23.20.1) births, 0.1 of which belonging to the northern subspecies *Ceratotherium s. cottoni*.

There were 31 (11.20) white rhino deaths, 1.0 of which belonging to the northern subspecies (No 19/LON C1) (age at death ca. 43 years). Seven animals died under the age of 2.

One wild born female reached the age of 41 during the reporting period (No 58 in Pretoria, dead in March 1987). (In January 1991 died the male No 71 (cottoni) reaching the age of ca. 37)

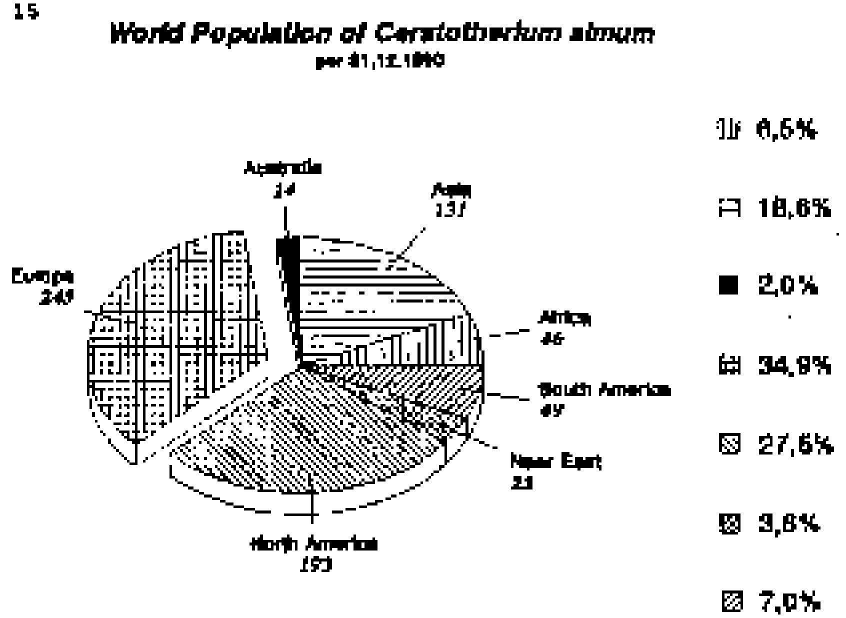
White rhinos are kept in all continents, largest number (245 individuals) living in Europe, followed by 193 animals in North America and 131 in the Asian region (figure 15).

Largest number of the subspecies *Ceratotherium s. cottoni* is kept in Dvur Kralove (CSFR) - 10 (3.7) animals. Two males aged 18 and 34 are kept in San Diego Wild Animal Park.

General age-structure of the living population clearly reflects the wild born population, imported in the 70s (figure 2).

A decline of births has become quite evident in the past 6 years.
Here we feel bound to point out that by the year 2.000 about 350 animals will have died of old age: The loss of one third of the present total population within that period can hardly be met by the expected birth-rate.

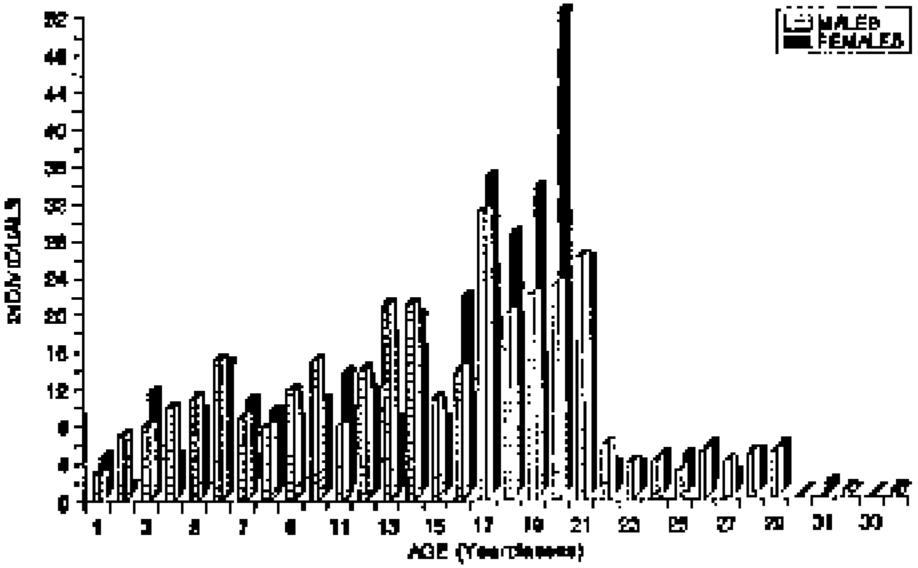
Figure 15



World Population of *Ceratotherium simum*
per 31.12.1990

Figure 16

Age Distribution of Ceratotherium simum
(living population) per 31.12.1991



About half of the live population lineal descent from 1st generation; only 24 animals descent from 2nd generation (figure 17).

Figure 17

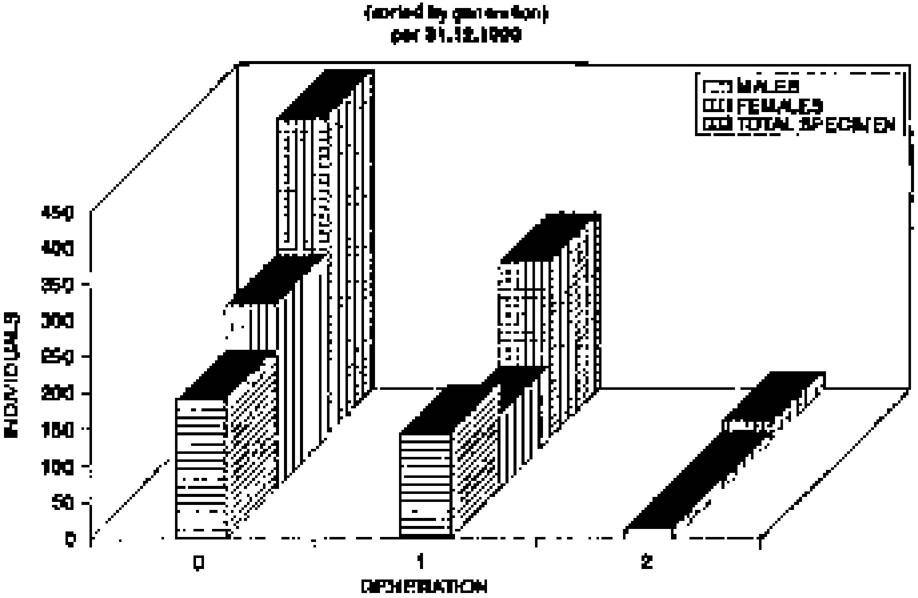
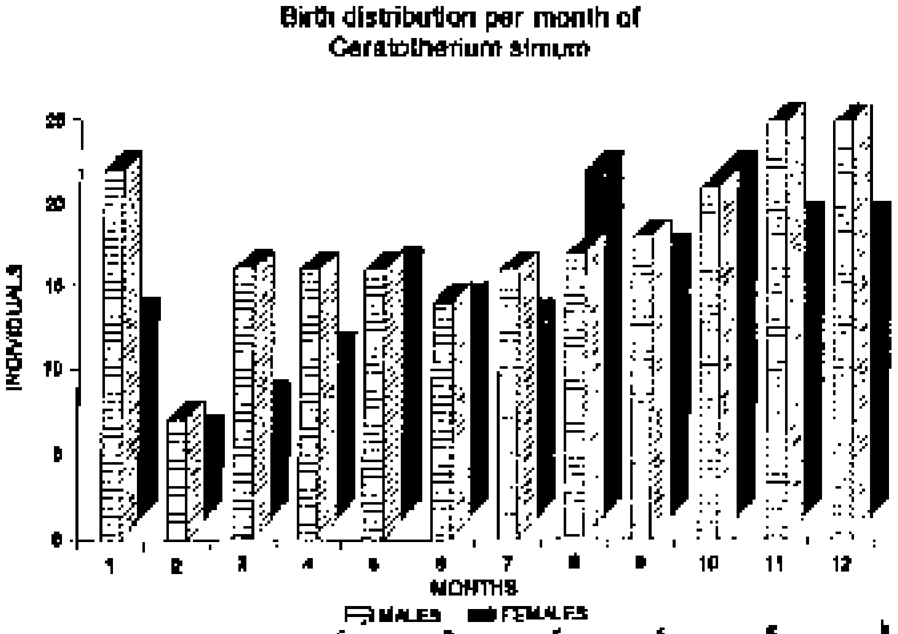
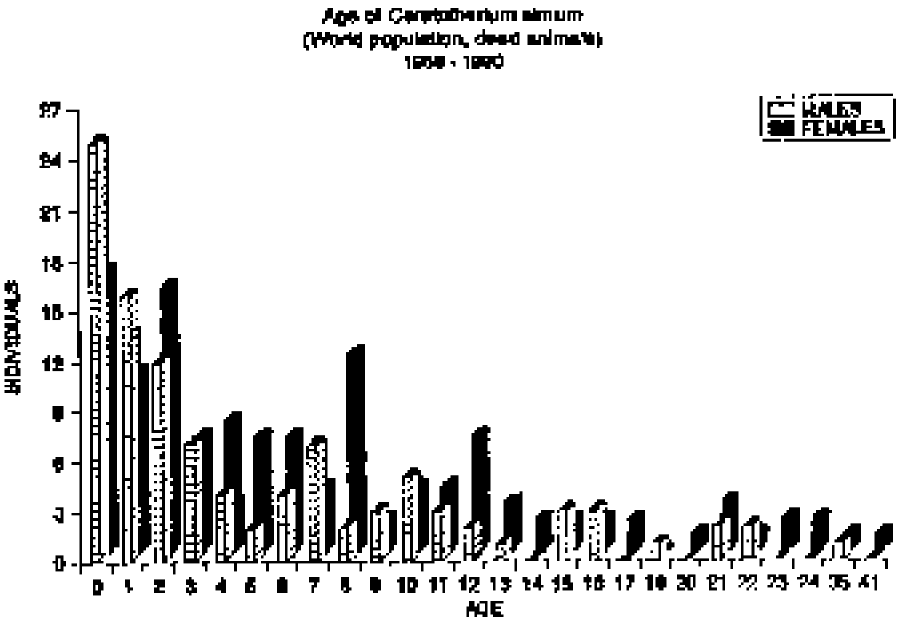


Figure 18



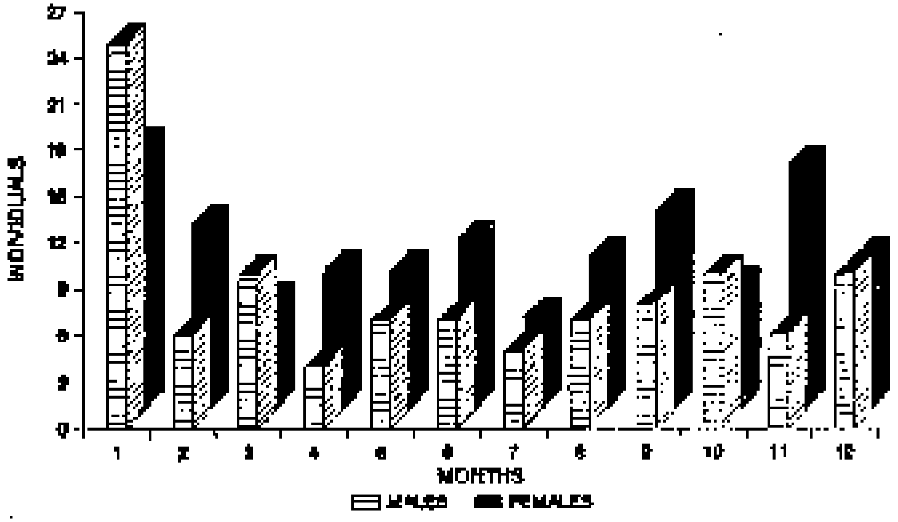
A decline of births is noted in February. An increase of births can be noted throughout spring and fall.
Most births occur from November through January (figure 18).

Figure 19



Death-rate is highest in subadult white rhinos, mainly in those under 2 years of age.
Highest death-rate occures in animals under the age of 1, above all in males.
A surprisingly high death-rate is found in 8 year old females.
One female died at the age of 41 (figure 19).
Death-rate is highest in January. For the rest of the year no specific trend shows (figure 20).

Figure 29 **Death distribution per month of *Ceratotherium simum* (1956 - 1990)**



Through non co-operative conduct of some US animal dealers problems arise keeping updated the International Studbook of White Rhinoceroses.

For years now EARL TATUM refuses to open line with the studbook keeper - although contacted on a regular basis. Whereabouts of a number of white rhino individuals thus remain in the dark. It is rather disturbing to us that members of AAZPA aware of this fact still do business with a man not caring to comply with internationally approved conservation demands.
I therefore wish to address a plea to the chairman of AAZPA to bring to bear his influence in that connection!

In the past years co-operation of INTERNATIONAL ANIMAL EXCHANGE (IAE) has gone off considerably!

Literature:

BROOKS, P. M. (1989): Proposed conservation plan for the black rhinoceros *Diceros bicornis* in South Africa, the TBVC states and Namibia. Koedoe 32/2. 1 - 30

REECE, R. W. (1990): Encouraging news from Zaire. The Rhino conservation newsletter Vol. 1, No 2, page 4

Berlin, January 1991

BENUTZERHINWEIS / USER HINT

Folgende Tiere mußten wegen ungeklärten Verbleibs bzw. Doppelregistrierung oder Falschmeldung im Zuchtbuch gestrichen werden.

Following animals had to be cancelled because of unknown whereabouts, double registration or wrong information submitted.

Spitzmaulnashorn / Black rhino:

studno.	stud-name	sex	birth-date	birth-place	sire/dam	name	last location	since	remarks
0059	[illegible] 4	m	23.??.67	[illegible]	44.57		unknown	06.11.64	whereabouts unknown
0164	TAN 1	f	00.00.6?	Kenya	n.e	Tess	[illegible]	25.06.71	ref. 0667 +
[illegible]	LEB 3	m	00.00.5?		0,0	[illegible]	Dresden	[illegible].75	ref. [illegible] +
[illegible]	TI 1	m	00.00.[illegible]		0,0		Tierpark Berlin	26.06.79	ref. [illegible] +
[illegible]	BE T	f	00.00.[illegible]		0,0	[illegible]	Berlin Zoo	[illegible].77	ref. [illegible]
[illegible]									number not issued
[illegible]	[illegible] 1	m	00.00.65			[illegible]	Atlanta	[illegible].73	ref. [illegible] +
[illegible]	SAN 7	m	00.06.[illegible]	S-Africa	0,0	[illegible]	[illegible]	08.1?.8?	ref. [illegible]
[illegible]	SAN 1	f	00.00.00	Zimbabwe	0,0	[illegible]	[illegible]	16.0?.8?	ref. [illegible]

Breitmaulnashorn / White rhino:

studno.	stud-name	sex	birth-date	birth-place	sire/dam	name	last location	since	remarks
[illegible]	[illegible] 3	f	00.00.[illegible]	Umfolozi	0,0	[illegible]	[illegible]	15.03.67	no reply
[illegible]	[illegible] 1	m	00.00.[illegible]		0,0	[illegible]	[illegible]	[illegible]	no reply
[illegible]	[illegible]	m	00.00.7?	Natal	0,0		[illegible]	[illegible]	no reply
[illegible]	[illegible] 2	m	00.00.[illegible]	Natal	0,0	[illegible]	Tenn. Safari	[illegible]	ref. [illegible]
[illegible]	[illegible] 5	m	00.00.[illegible]	Umfolozi	0,0	[illegible]	[illegible] Zoo	17.0?.73	ref. [illegible]
[illegible]	[illegible] 2	f	00.00.[illegible]	Umfolozi	0,0	[illegible]	[illegible] Zoo	17.0?.73	ref. [illegible]
[illegible]	[illegible] 1	m	00.00.[illegible]	Umfolozi	0,0	[illegible]	[illegible]	20.0?.73	no reply
[illegible]	[illegible] 2	f	00.00.[illegible]	Umfolozi	0,0	[illegible]	[illegible]	20.0?.73	no reply
[illegible]	[illegible] 1	m	00.00.[illegible]	S-Africa	0,0		[illegible]	21.02.77	no reply
0576	[illegible] 1	m	[illegible].06.7?	[illegible]	416.025	Hercules	Medellin	19.11.8?	no reply
0591	[illegible] 7	m	12.06.80	Hodenhagen	492.?56	Charles	[illegible]	00.00.85	no reply
[illegible]	SAN [illegible]	f	00.00.[illegible]	Natal	0,0		[illegible]	20.04.73	whereabouts unknown
[illegible]	[illegible]	m	[illegible].07.82	[illegible]	852,135		Medellin	27.11.85	no reply
0652	[illegible] 2	f	03.11.80	[illegible]	0.0	[illegible]	Medellin	24.09.82	no reply
[illegible]	[illegible]	f	23.11.80	[illegible]	470,029		[illegible]	15.06.81	no reply
[illegible]	[illegible]	f	02.12.[illegible]	[illegible]	470.028		[illegible]	25.06.83	no reply
0735	[illegible]	m	00.00.00.	S-Africa	0,0		[illegible] Game Farm	[illegible]	no reply
0779	[illegible] 4	f	12.06.85	Hodenhagen	[illegible]	Natal	[illegible]	22.5.85	no reply
0786	[illegible]	m	08.0?.82	SDW	852,150	[illegible]	[illegible]	01.06.83	ref. [illegible]
0787	[illegible]	f	30.12.82	SDW	852,147		Metro Zoo	14.01.8?	ref. [illegible]
[illegible]	[illegible]	m	01.[illegible].85	Hilvarenbeek	271,005	[illegible]	unknown	30.1?.86	whereabouts unknown
[illegible]	[illegible] 3	m	00.00.79	Kenya	0,0	[illegible]	[illegible]	24.10.85	ref. [illegible]
[illegible]	[illegible] 2	f	00.00.79	Kenya	0,0	[illegible]	[illegible]	04.10.85	ref. [illegible]
0910	[illegible] 4	m					[illegible] Saf.	0?.05.86	cancelled: wrong information submitted
[illegible]	[illegible]	f					[illegible] Saf.	[illegible]	same as above (no rhino but elephant!)

Abkürzungen für Ländernamen

Abbreviations for name of countries

Land	Kürzung	Country	Abbreviation
Abu Dhabi	ADB	Abu Dhabi	ADP
Äthiopien	ET	Ethiopia	ET
Argentinien	ARG	Argentina	ARG
Australien	AU	Australia	AU
Belgien	B	Belgium	B
Brasilien	BR	Brazil	BR
Bulgarien	BUL	Bulgaria	BUL
Burma	BUR	Burma	BUR
China	PRC	China	PRC
CSFR	CSS	Czechoslovakia	CSS
Dänemark	DK	Denmark	DK
Deutschland	FRG	Germany	FRG
Dominikanische Republik	DOM	Dominican Republic	DOM
Frankreich	F	France	F
Großbritannien	GB	United Kingdom	GB
Guatemala	GUA	Guatemala	GUA
Holland	NL	Netherlands	NL
Indien	IND	India	IND
Indonesien	INS	Indonesia	INS
Iran	IRN	Iran	IRN
Irland	EIR	Eireland	EIR
Israel	IL	Israel	IL
Italien	I	Italy	I
Japan	J	Japan	J
Jugoslawien	YU	Yugoslavia	YU
Kanada	CDN	Canada	CDN
Korea	KOR	Korea	KOR
Kuba	C	Cuba	C
Malaysia	MAL	Malaysia	MAL
Marokko	MA	Morocco	MA
Mexiko	MEX	Mexico	MEX
Neuseeland	NZL	New Zealand	NZL
Nigeria	NIG	Nigeria	NIG
Polen	PL	Poland	PL
Portugal	P	Portugal	P
Puerto Rico	PUE	Puerto Rico	PUR
Katar	QAT	Qatar	QAT
Rumänien	RUM	Romania	RUM
Saudi Arabien	SAU	Saudi Arabia	SAU
Schweiz	CH	Switzerland	CH
Singapur	SIN	Singapore	SIN
Spanien	E	Spain	E
Sri Lanka	SRL	Sri Lanka	SRL
S-Afrika	RSA	S-Africa	RSA
Taiwan	TW	Taiwan	TW
Thailand	THA	Thailand	THA
Türkei	TUR	Turkey	TUR
Unbekannt	[illegible]	unknown	UNK
Ungarn	H	Hungary	H
Uruguay	URU	Uruguay	URU
UdSSR	USR	USSR	USR
Venezuela	VEN	Venezuela	VEN
Vereinigte Staaten von Amerika	USA	United States of America	USA

ÜBERBLICK ÜBER DEN SPITZMAULNASHORN-WELTBESTAND

PER 31.12.1990

SURVEY ON BLACK RHINO WORLDPOPULATION

PER 31.12.1990

WORLD POPULATION OF BLACK RHINOCEROS
[Survey per 31.12.1990]

LOCATION	TOTAL	MALES	FEMALES
ADDO	2	1	1
AJA ZOO	4	2	2
ATLANTA	1	1	0
BASS RANCH	3	1	2
BERLIN ZOO	8	3	5
BROOKFIELD	4	2	2
BUENOS AIRES	1	0	1
CAIRO	1	1	0
CHESTER	2	1	1
CHICAGO	3	1	2
CINCINNATI	3	1	2
COLOMBO	4	2	2
COLORADO SPRING	2	1	1
COLUMBUS ZOO	4	2	2
DALLAS	5	1	4
DENVER	5	3	2
DETROIT	2	1	1
DVUR KRALOVE	10	3	7
FORT WORTH	3	2	1
FRANKFURT/M	3	2	1
GARDEN CITY	1	1	0
HIGASHIYAMA ZOO	1	1	0
JOS	1	1	0
KAMINE ZOO	4	2	2
LA HABANA	2	1	1
LINN	4	1	3
LISBON	4	2	2
LONDON ZOO	3	1	2

WORLD POPULATION OF BLACK RHINOCEROS
[Survey per 31.12.1990]

LOCATION	TOTAL	MALES	FEMALES
LOS ANGELES	6	2	4
MAGDEBURG	4	2	2
MAIDUGURI	2	0	2
MEXICO CITY	2	1	1
MIAMI METRO	5	2	3
MILWAUKEE	4	2	2
MYSORE	4	2	2
NAGOYA	2	0	2
NAPLES	3	1	2
NEGARA ZOO	1	1	0
NEW DELHI	2	1	1
OKLAHOMA	2	0	2
OSAKA	2	1	1
PEKING	3	1	2
PORT LYMPNE	9	4	5
POTGIETERSRUS	1	0	1
POTTER PARK ZOO	1	1	0
PRETORIA	1	1	0
PYONGYANG	4	2	2
ROME	1	0	1
SAN ANTONIO	3	1	2
SAN DIEGO WILD	6	4	2
SAN DIEGO ZOO	4	2	2
SAN FRANCISCO	3	1	2
SANDTON	1	1	0
SAO LEOPOLDO	1	0	1
SEITO ZOO	1	1	0
SEOUL	1	1	0

WORLD POPULATION OF BLACK RHINOCEROS
(Survey per 31.12.1990)

LOCATION	TOTAL	MALES	FEMALES
ST.LOUIS	3	1	2
SYDNEY	2	0	2
TAIPEI	3	1	2
TALLINN	2	1	1
TAMPA	2	1	1
TEHERAN	5	2	3
TYLER	3	2	1
WASHINGTON	2	1	1
WICHITA	1	1	0
ZURICH	6	2	4
66	195	88	110

SPITZMAULNASHORN-WELTBESTAND

PER 31.12.1990

BLACK RHINO WORLDPOPULATION

PER 31.12.1990

ÜBERBLICK ÜBER DEN BREITMAULNASHORN-WELTBESTAND

PER 31.12.1990

SYRVEY ON WHITE RHINO WORLDPOPULATION

PER 31.12.1990

WORLD POPULATION OF WHITE RHINOCEROS
(Survey per 31.12.1990)

LOCATION	TOTAL	MALES	FEMALES
AALBORG	2	0	2
ADVENTURE WORLD	9	4	5
AKIYOSHIDAI P.	4	1	3
AL AIN	2	1	1
ALBUQUERQUE	2	1	1
ALEXANDRIA	1	1	0
AMARILLO	6	4	2
ANTWERP	2	1	1
APELDOORN	2	1	1
ARNHEM	8	2	6
ASHEBORO	4	2	2
AUCKLAND	2	1	1
AUGSBURG	2	1	1
BAKER	3	1	2
BANDHOLM	4	2	2
BANGKOK	5	1	4
BARCELONA	3	1	2
BARQUISIMETO	4	2	2
BAYOU WILDLIFE	3	3	0
BELO HORIZONTE	1	0	1
BERLIN TIERPARK	1	1	0
BERLIN ZOO	2	1	1
BEWDLEY	2	1	1
BIRMINGHAM/USA	3	1	2
BLACKPOOL	3	1	2
BLOEMFONTEIN	3	1	2
BOGOR	4	3	1
BOKSBURG	2	2	0
BORAS	2	1	1
BROOKFIELD	5	1	4
BROWNSVILLE	4	2	2
BUDAPEST	2	1	1
BURFORD	3	1	2
BUSSOLENGO	2	1	1
CAIRO	2	0	2
CALARASI ZOO	1	1	0
CALGARY	2	1	1

WORLD POPULATION OF WHITE RHINOCEROS
(Survey per 31.12.1990)

LOCATION	TOTAL	MALES	FEMALES
CANTON	1	1	0
CARABOBO	4	1	3
CARACAS	2	1	1
CATSKILL	2	1	1
CENTER HILL	1	1	0
CHRISTCHURCH	4	2	2
CIRCO DE MADRID	1	1	0
CIRCO FLOASCA	1	1	0
CIRCUS ALTHOFF	1	1	0
CLEVELAND	2	1	1
CLIFTON	5	2	3
COLCHESTER	2	1	1
COLUMBIA	3	2	1
COLUMBUS	3	1	2
COPENHAGEN	3	1	2
DELAND	2	1	1
DOHA	7	2	5
DORTMUND	1	1	0
DOSWELL	4	3	1
DUBBO	4	1	3
DUBLIN	2	1	1
DUISBURG	2	1	1
DVUR KRALOVE	12	4	8
EARL TATUM	3	3	0
EDINBURGH	4	1	3
EDMOND	2	2	0
EINBECK	1	1	0
EMMEN	2	1	1
ERFURT	2	1	1
FASANO	2	1	1
FERNDALE	9	4	5
FORT WORTH	1	0	1
FOSSIL RIM	1	0	1
FRESNO	1	0	1
FUJI SAF. PARK	14	8	6
FUKUOKA ZOO	2	1	1
GDANSK	1	1	0

WORLD POPULATION OF WHITE RHINOCEROS
(Survey per 31.12.1990)

LOCATION	TOTAL	MALES	FEMALES
GELSENKIRCHEN	1	0	1
GENK	6	3	3
GENTRY	1	1	0
GIVSKUD	4	2	2
GLASGOW	2	1	1
GLEN ROSE	1	1	0
GRANBY	1	1	0
GUADALAJARA	2	1	1
GUADALUPE	1	0	1
GUATEMALA CITY	2	1	1
GUNMA SAF.WORLD	7	3	4
HAINES CITY	1	0	1
HALLE	2	1	1
HANNOVER	2	1	1
HARBIN ZOO	2	1	1
HEIDELBERG	2	1	1
HELICAPTURE	1	1	0
HILVARENBEEK	7	1	6
HIMEJI C. PARK	5	2	3
HODENHAGEN	6	3	3
HONOLULU	2	1	1
HOUSTON	3	1	2
IZU BIO PARK	4	1	3
JACKSONVILLE	4	2	2
JACKSON, MICH.	1	1	0
JACKSON, MISS.	3	1	2
JAKARTA	2	1	1
JOHANNESBURG	3	1	2
JOHN HOOP	1	1	0
KAGOSHIMA ZOO	2	1	1
KALININGRAD	2	1	1
KANAZAWA ZOO	1	0	1
KAOHSIUNG CITY	3	2	1
KATOWICE	3	1	2
KAUNAS	3	2	1
KIEV	2	1	1
KINGS ISLAND	2	1	1

WORLD POPULATION OF WHITE RHINOCEROS
(Survey per 31.12.1990)

LOCATION	TOTAL	MALES	FEMALES
KINGS MILLS	3	0	1
KNOXVILLE	8	2	6
KOBE ZOO	2	1	1
KOLMARDEN	2	1	1
KRECHTING	3	3	0
KREFELD	2	1	1
KUMAMOTO ZOO	3	1	2
KWALATA GAME R.	1	1	0
KYUSHU LION SAF	9	5	4
LA HABANA	7	2	5
LA PLATA	2	1	1
LAHORE	2	1	1
LANGATO SAFARI	2	1	1
LEIPZIG	2	1	1
LES MATHES	3	2	1
LESNA	2	1	1
LIBEREC	2	1	1
LISBON	2	1	1
LITTLE ROCK	2	1	1
LLANO	2	1	1
LODZ	1	1	0
LOUISVILLE	3	1	2
MADISON	3	1	2
MADRID	2	1	1
MALLORCA	2	1	1
MEMPHIS	2	1	1
MEXICO CITY	1	1	0
MIAMI METRO	2	0	2
MIDDELKOOP	1	1	0
MILWAUKEE	1	1	0
MIYAZAKI SAFARI	5	1	4
MONTEVIDEO	1	0	1
MORELIA	1	1	0
MOSCOW	1	0	1
MOUNT ULLA MAM.	1	1	0
MOUNTAIN HOME	2	1	1
MUNICH	3	1	2

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WORLD POPULATION OF WHITE RHINOCEROS
(Survey per 31.12.1990)

LOCATION	TOTAL	MALES	FEMALES
MUNSTER	6	2	4
MYSORE	3	2	1
NABOOMSPRUIT	2	2	0
NAGASAKI BIO P.	2	1	1
NAGASAKI SAFARI	4	2	2
NASU SAFARI P.	2	2	0
NATAL LION PARK	1	0	1
NEW ORLEANS	4	2	2
NORFOLK	2	1	1
NORTHLAND WILD	1	1	0
OCALA	1	1	0
OKINAWA PARK	1	1	0
OMAHA	2	1	1
OSNABRUCK	2	1	1
OSTRAVA	2	1	1
PAIGNTON	2	1	1
PARIS	2	1	1
PEKING	2	1	1
PHOENIX	4	3	1
PISTOIA	2	1	1
PITTSBURGH	2	1	1
PLAISANCE ZOO	1	1	0
PRAGUE	3	1	2
PRESCOT	4	3	1
PRETORIA LICHT.	5	1	4
PRETORIA SHEN.	1	1	0
PRETORIA ZOO	3	2	1
PUEBLA	5	3	2
PUERTO RICO	1	0	1
PYONGYANG	3	1	2
RAMAT GAN	16	10	6
RANGOON	2	1	1
RAPPERSWIL	2	1	1
RIO DE JANEIRO	2	1	1
RIYADH	2	1	1
ROCKTON	4	2	2
ROME BORDI ZOO	2	2	0

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WORLD POPULATION OF WHITE RHINOCEROS
(Survey per 31.12.1990)

LOCATION	TOTAL	MALES	FEMALES
ROME GRUNWALD	1	1	0
ROSTOV	2	1	1
SALT LAKE CITY	2	1	1
SAN ANTONIO	3	2	1
SAN DIEGO WILD	16	5	11
SANDTON	4	4	0
SANTO DOMINGO	6	3	3
SAO PAOLO	2	1	1
SARASOTA	1	1	0
SCHWERIN	2	1	1
SENDAI ZOO	2	1	1
SICILIA ZOO	1	0	1
SIGEAN	4	2	2
SINGAPORE	1	1	0
SOEST,V.D.BRINK	3	1	2
SOFIA	3	1	2
SOUTH PERTH	1	1	0
STEELPOORT	1	0	1
STOLBERG	1	1	0
STUKENBROCK	2	1	1
SUBARU PARK	2	1	1
SURABAJA	2	1	1
TAIPEI LEOFOO	12	3	9
TAIPEI ZOO	2	2	0
TAIYUAN	2	1	1
TAMPA	1	1	0
TEMARA	2	1	1
THOIRY	3	2	1
TIPPARARY	1	1	0
TIPPERARY	1	1	0
TOBU ZOO	2	1	1
TOHOKU	1	0	1
TOKYO UENO ZOO	2	1	1
TOLEDO	4	1	3
TOLUCA	2	1	1
TORONTO	4	2	2
TOUCHSTONE	1	1	0

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WORLD POPULATION OF WHITE RHINOCEROS
(Survey per 31.12.1990)

LOCATION	TOTAL	MALES	FEMALES
TOUROPARC	2	1	1
TRANSVAAL	10	7	3
TUCSON	2	1	1
TULSA	3	1	2
TUNIS	3	1	2
UNKNOWN	6	1	5
USTI NAD LABEM	5	2	3
VALLEJO	2	2	0
VANCOUVER	4	1	3
WARMINSTER	6	3	3
WERRIBEE	2	1	1
WEST PALM BEACH	9	5	4
WHIPSNADE	8	2	4
WILDLIFE WORLD	1	1	0
WINCHESTER	4	2	2
WINDSOR	6	2	4
WINSTON	2	2	0
WOBURN	6	4	2
WROCLAW	2	1	1
YUBARI HAIJI F.	1	1	0
YULEE	3	2	1
ZAGREB	2	1	1
			362
		346	
	708		
245			

* 1 unknown sex in Pretoria Lichtenburg

RHINO GLOBAL CAPTIVE ACTION PLAN WORKSHOP

BRIEFING BOOK

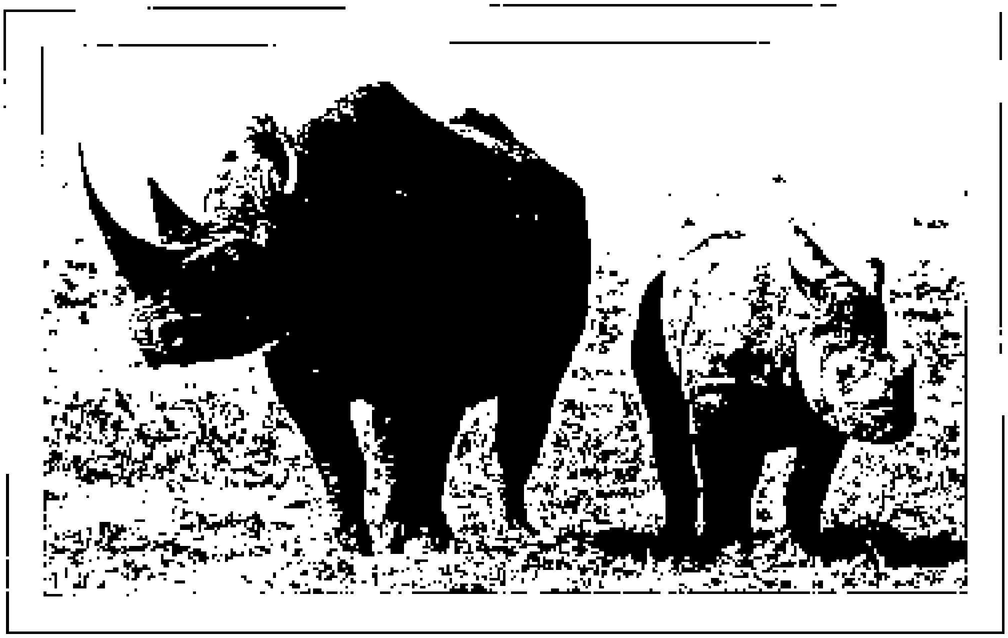
LONDON ZOOLOGICAL GARDENS
9-10 MAY 1992

SECTION 18

SSC AFRICAN RHINO ACTION PLAN

African Elephants and Rhinos

Status Survey and Conservation Action Plan



Compiled by

D. H. M. Cumming, R. F. Du Toit and S. N. Stuart

IUCN/SSC African Elephant and Rhino Specialist Group

The conservation situation surrounding Africa's elephants and rhinos is evolving very rapidly. This document describes the situation as it was in 1987 in detail, and presents a number of recommended actions. This report has already been used in the formulation of conservation policies for elephants and rhinos in many African countries, and has catalysed increased donor interest and activity on behalf of these species. In view of the rapidly changing situation, IUCN and the other organizations associated with this publication are likely to revise their policies, particularly as they involve the control and regulation of the international trade in ivory.

This publication is produced by IUCN - The World Conservation Union, with the collaboration of the United Nations Environment Programme (UNEP), the World Wide Fund for Nature (WWF), Wildlife Conservation International (WCI), the African Wildlife Foundation (AWF), the Save African Endangered Wildlife Foundation (SAVE), and the African Fund for Endangered Wildlife (AFEW).

ISBN 2-88032-975-2

Published by IUCN, Gland, Switzerland.

Camera-ready copy produced by
The Nature Conservation Bureau
122 Derwent Road, Thatcham RG13 4UP, UK

Printed by Thatcham Printers, Bath Road, Thatcham, UK

Cover photo: Black rhino and calf (Mark Boulton/WWF)

RHINO GLOBAL CAPTIVE ACTION PLAN WORKSHOP

BRIEFING BOOK

LONDON ZOOLOGICAL GARDENS
9-10 MAY 1992

SECTION 19

SSC ASIAN RHINO ACTION PLAN

RHINO GLOBAL CAPTIVE ACTION PLAN WORKSHOP

BRIEFING BOOK

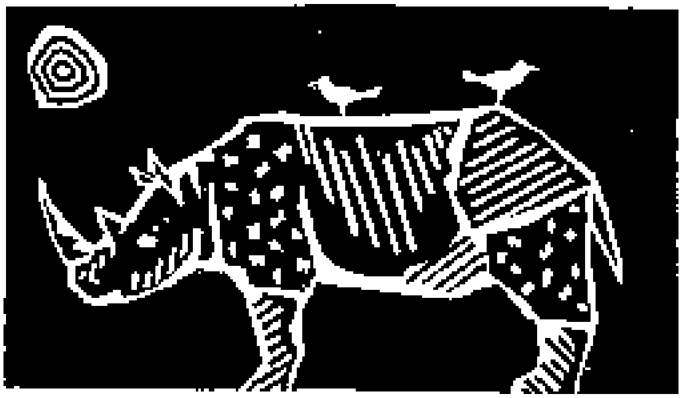
LONDON ZOOLOGICAL GARDENS
9-10 MAY 1992

SECTION 20

SAN DIEGO RHINO CONFERENCE

75th Anniversary of the Zoological Society of San Diego

INTERNATIONAL
·R·H·I·N·O·
CONFERENCE



SAN DIEGO 1991

RHINOCEROS BIOLOGY AND CONSERVATION

MAY 9 - 11, 1991

Hanalei Hotel
San Diego, California, USA

Oliver A. Ryder, Ph.D., Organizer
Center for Reproduction of Endangered Species
Zoological Society of San Diego
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INTERNATIONAL
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CONFERENCE
SAN DIEGO 1991

75th Anniversary of the Zoological Society of San Diego

RHINOCEROS BIOLOGY AND CONSERVATION

MAY 9 - 11, 1991
San Diego, California, USA

CONFERENCE REPORT

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75th Anniversary of the Zoological Society of San Diego

RHINOCEROS BIOLOGY AND CONSERVATION

MAY 9 - 11, 1991
San Diego, California, USA

HIGHLIGHTS AND SUMMARY

The International Conference on Rhinoceros Biology and Conservation was the first conference to consider the plight of all five species of rhinoceros. Sponsored by the Zoological Society of San Diego, it was held May 9-11, 1991 at the Hanalei Hotel in Mission Valley. Over 30 countries were represented and the over 300 registrants included governmental representatives, zoo biologists, field biologists, representatives of non-governmental conservation organizations, veterinarians and academic scientists.

The conference attracted considerable media interest. Coverage included the New York Times, Los Angeles Times, San Diego Union and Tribune, San Diego television, CNN as well as by Science, Discover and New Scientist magazines. Radio interviews included local and state-wide Public Radio shows. KIRO radio in Seattle and Radio 2 in Sydney, Australia also conducted live interviews.

The basic scientific sessions included discussions of genetics, reproductive biology, veterinary medicine, and poster presentations provided new information about nutrition, disease, and other aspects of rhinoceros biology, including the first report of vocal communication in both African and Asian rhinos involving subsonic sounds.

Other technical sessions focused on the status of each of the five rhinoceros species, the development and implementation of plans for conservation of rhinos in separate nations in which rhino populations survive and the status of the four species of rhinoceros currently held in zoological parks.

Keynote addresses included the latest information on the international commerce in illegal rhinoceros products (Esmond Bradley Martin), the spiritual value of habitats with rhinos in an increasingly urban world (Rolf Benirschke), a strategic overview of what humans must really do to save the rhinoceros species (Mark Stanley Price), and a direct and personal plea from the Rhino Man, native Kenyan Michael Werikhe, for international assistance in securing rhino populations for the future.

Nearly 30 manuscripts were collected at the conference for the edited volume that will include the papers presented at the conference as well as additional contributions that were not included in the conference. This extensive book will be the first compilation of information on the biology and conservation of all five species of rhinoceros.

The conference office was busy on a nearly 24-hour basis. A conference news bulletin provided the latest information about the scheduling of working groups, revisions in the conference program, and other conference news. Summaries of the plenary sessions were entered into word processing files as were reports of working groups and draft resolutions. All these materials were combined and duplicated so that copies were available to all for discussion in the final plenary session. The reviewed and approved reports form the basis of the Conference Report that highlights the current situation for each species of rhinoceros and delineates directions for research, zoo and field conservation action. Thus, matters of consensus for conservation action as well as controversy in conservation methodology are made explicit and available.

75th Anniversary of the Zoological Society of San Diego
International Conference on Rhinoceros Biology and Conservation
May 9-11, 1991, San Diego, California, USA

CONFERENCE RESOLUTION

The Conference encourages the international donor community to consider the five species of rhino in Africa and Asia as flagship and umbrella species for conserving biodiversity and critical ecosystems. The critically endangered status of these species emphasizes the urgent need for immediate conservation action and funding. The Conference urges the donor community to use the Global Environmental Facility of The World Bank to fund conservation projects in Africa and Asia that protect rhinos and their habitats, involve local community participation in rhino management and conservation education and awareness programs.

(This resolution was unanimously approved at the final plenary session)

Keynote Addresses

Esmond Bradley Martin:	*The present-day trade routes and markets for rhinoceros products*
Rolf Benirschke:	*The spiritual value of habitats with rhinos in an increasingly urban world*
Mark R. Stanley Price:	*What will it take to save the rhino?*
Michael Werikhe:	*The rhino will live or die because of us*

Plenary I - Summary
Rhinoceros Evolution and Systematics: Conservation Implications

R. Aman, chair: *Genetic analysis of rhino populations in Kenya*
G. Amato: *Molecular evolution in rhinos*
M. George: *Mitochondrial DNA analysis of rhinoceros subspecies*
E. Harley: *Molecular Genetic studies of Southern African black rhinoceros*
D. Prothero: *Fifty million years of rhinoceros evolution*
O. Ryder: *Rhinoceros chromosomal studies: Application to gene pool conservation*
N. van der Merwe & A. Hall-Martin: *The determination of species and geographic origin of rhinoceros horn by isotopic analysis*

Fossil records indicate that the evolutionary history of rhinoceroses dates back to 50 million years ago. The newer molecular genetic techniques are quite useful in tracing the relatively recent evolutionary history of the five extant species of rhinos. What implications do these new techniques have from the conservation point of view? Here the concerns require a practical application of information gathered from such techniques. The questions may be: Is there a genetic basis for the species divisions at the sub-species level? Are such genetic differences between the sub-species large enough to contraindicate managing them at the sub-species level or are they small enough so that strategy of management could be dictated by factors other than genetic? Can these techniques determine with certainty the identity and relationships of individuals within a population? And from the point of view of regulation in trade of rhino products and forensics, can these techniques lead to identification of such products and trace their points of origin? It is clear from the proceedings that these new approaches hold great promise in providing answers to such questions.

Summary Report

This session opened with a brief description by Dr. Aman of efforts underway in Kenya in setting up a molecular genetics lab to conduct research on assessing genetic variation within large wildlife mammals within the region using a DNA-based approach. A project in collaboration with Dr. Ryder and CRES, to examine genetic variation in black rhinos in Kenya has already been initiated. An interesting introduction on the subject of rhinos was provided by Dr. Prothero who traced back the evolutionary history of this family over the last 50 million years since its origin. Rhinoceroses were at one time dominant large land mammals on all the northern continents and in Africa and comprised over 65 genera that occupied diverse ecological niches. Today only five species in four genera survive.

Dr. Ryder described his work on analysis of chromosomes of the African rhino. Karyotypes of the northern and southern black rhino were found to be similar in terms of chromosome numbers but dissimilar when the proportion of biarmed chromosomes was examined. In a chromosomal survey of 7 black rhinos from Zimbabwe and 22 black rhinos from Kenya, the distribution of chromosome arm lengths was found to follow a bimodal pattern grouped according to origin. This may be reflecting changes in heterochromatin as a result of a recent lack of gene flow between populations in the two regions.

At the DNA level, low levels of intraspecific variation are observed in the two African species of rhino. By analysis of mitochondrial DNA restriction fragment length polymorphisms, Dr. George found that the level of genetic variation ranged between 0 and 0.07% among northern white rhinos and between 0 and 0.04% among southern white rhinos. The differences between northern and southern white rhinos ranged between 1 and 1.4%. Much larger levels of variations ranging from 4.2 to 5% were observed between the white and the black rhino species. Using the same technique, Dr. Harley reported a similar level of sequence divergence of 6.8 ± 1.6% between the two species of African rhino which translated to a divergence time of 3.4 ± 0.8 million years. Harley also found that mitochondrial haplotypes that were unique to *D.b. minor*, *D.b. bicornis*, and *D.b. michaeli* could be defined and could serve as useful markers for those subspecies. He noted that the amount of divergence between the black rhino sub-species represented by these changes was small. Thus, there was no indication to maintain these subspecies separately based on mitochondrial DNA distance estimates. Any outbreeding depression as a result of subspecies interbreeding would be quite unlikely and the choice, therefore, of management strategy would have to be dictated by other factors such as the preservation of some desirable morphological, behavioral, or adaptive specializations.

Data on genetic variation as assessed by the finest level of resolution, that is DNA sequencing, was presented by Dr. Amato. He described the merits of the powerful and versatile polymerase chain reaction (PCR) and its application to rhino genetics. DNA sequence information generated by analysis of PCR amplified products from the 12S and 16S ribosomal genes of the mitochondrial genome was used to construct phylogenetic trees for four species of the rhino using the cow or zebra as outgroups. The phylogenies strongly supported the monophyly of the African species. Both the Sumatran and Indian rhinos separated as another branch with a distant lineage split. Dr. Amato also described a new technique called RAPD (random amplified polymorphic DNA markers) that seems to hold better promise in paternity and pedigree analysis in rhinos than the conventional DNA fingerprinting techniques. The technique also has the advantage that there is no need for Southern blotting and hybridization with radioactive probes in generating data.

That techniques developed in other scientific disciplines can be applied to resolve zoogeographical separation in genetics was demonstrated by Dr. van der Merwe. He presented data on the measurements of light stable isotopes such as S, C, H, O, and N in specimens of rhino horn to determine the species of rhino that the sample originated from and its geographic origin. Carbon isotope ratios ($^{13}C/^{12}C$) are sufficient for species identification because of the natural differences in this ratio in the vegetation types that the two species of African rhino feed on, i.e. browse vs. grasses. Analysis of $^{13}C/^{12}C$ ratios in horn material from the two African rhino species resulted in an unequivocal identification of the species. Identification of the geographic origin, however, is more complex and requires multiple analysis of isotope ratios including $^{15}N/^{14}N$ (which correlates with rainfall) and heavy isotope ratios of Sr, Pb, and Nd (which register the age of geological substrate). Multivariate cluster analysis of these isotopes ratios was found to separate the geographic refuges with very little overlap, thereby identifying the geographic origin of the sample.

Plenary II - Summary
Biology and Conservation of the Greater One-Horned Rhinoceros

E. Dinerstein, chair: *Demographic characteristics of greater one-horned rhinoceros populations*
Sunder P. Shrestha: *The role of translocation of greater one-horned rhinos in species conservation: The Bardia Park example*
G. McCracken: *Genetic variation in the greater one-horned rhino and implications for population structure*
Satya Priya Sinha: *Management of the reintroduced great one horned rhinoceros (Rhinoceros unicornis) in Dudwa National Park, Uttar Pradesh, India*

This session took a conservation biology approach to the management of this species. We first looked at some of the demographic considerations of this population which have been under study over the last few years and found that the Chitwan and Kaziranga populations (essentially the only viable population at the moment) had made significant recovery since the early 1900s, when they were down to very low levels. In the case of the Kaziranga population, its numbers decreased to less than a hundred individuals; for the Chitwan population, the low point was between 60 and 80 individuals in 1957. These rhino populations are an example of how adequate protection and sufficient habitat can lead to recovery.

In looking at the genetics of this population a rather startling and interesting discovery was made. The average heterozygosity in greater one-horned rhinoceroses approaches the highest levels recorded for free-ranging mammals. Gary McCracken explained how, through the historical demography of this species, genetic diversity might have been maintained in spite of the population bottleneck. The speakers in this session also recognize that the remnants of a population almost going extinct may still carry high levels of genetic variability, and thus the next step in any effort to conserve the species is to reestablish these populations within the historic range of the species, particularly in areas that are now well protected and where there is adequate habitat.

Dr. Shrestha from Nepal and Dr. Sinha from Uttar Pradesh gave examples of where translocations have begun. In the very successful reintroduction and translocation of rhinoceros from Chitwan the population at Bardia is now up to 38 individuals. There have been five births. Of the first installment of rhinos that were sent there in 1986, all those born were from females that were bred in national parks, rather than females that arrived pregnant. Dr. Sinha reported on a different, opposing scenario involving the Dudwa Sanctuary population for which it appears unlikely at the moment there is enough habitat within the Dudwa Sanctuary to support a viable population.

There are a number of other areas within the historic range of the greater one-horned rhinoceros that are available for future translocation efforts. From Dr. Shrestha's work it is clear that the technology is available for the translocation of animals and a high success rate may be anticipated, unlike some of the problems we heard about with black rhinos. Thus, the translocations should become a very important part of the conservation activities for *Rhinoceros unicornis*.

Plenary III - Summary
African Rhino Status and Conservation Plans

C. Gakahu, chair: *African rhinos: Current numbers and distribution*
R. Brett: *The management of rhinos in sanctuaries in Kenya*
P.M. Brooks: *Conservation plan for the black rhinoceros in South Africa, the TBVC states and Namibia*
K.H. Smith: *Conserving rhinos in Garamba National Park*
M. Atalia: *Strategies for the conservation of rhino in Zaire*
N. Steele: *Development and management of rhino sanctuaries in South Africa; The effects of socio economic and political changes in Southern Africa on developments*

1. Numbers, distribution, and whether the trend of population(s) is decreasing, stable, or increasing in sanctuaries, nations, or regions are the basis of assessing status and therefore, vital data for management and conservation of rhinos. The databases for rhino populations should progress toward continuous monitoring of births and deaths, including, when possible, the identification of individuals. A permanent and centralized database should be established.

2. The required field surveys and monitoring are expensive and require finance, personnel, and equipment. These requirements must therefore be used rationally for max output. Finance and equipment are a major problem and assistance is required. Efforts should therefore be concentrated in areas with significant (viable) numbers of rhinos.

3. Sanctuaries offer great hope and future for rhinos, but they must be actively managed and supported by long term intensive monitoring of all aspects including vegetation, food and nutrition requirements, genetics, and disease together with physiology and veterinary needs especially for capture and translocation.

4. Objectives of conservation of rhinos can only be achieved through the implementation of co-ordinated management programs involving management of existing populations, establishment of new populations and support for captive breeding programs.

5. The main factors likely to affect the future of African rhinos ranked in order of importance are poaching, civil unrest from within and outside national boundaries, habitat changes, genetics, and inbreeding in relation to the demographic data.

6. When discussing, developing strategies and conservation plans, the socio-economic and political factors must never be underestimated. The basic survival needs of people who shoulder the cost of supporting wildlife should be catered for by the conservation programmes. Their active participation through education, understanding of benefits from wildlife (rhino included), extension and community based conservation is vital for sustained management of the natural resource base which rhinos are part of. This is both a short and long term strategy and it should not be above the most urgent and, hopefully, short term security enhancement for rhinos in sanctuaries, private lands, and government conservation areas.

Plenary IV - Summary
Captive and Other Managed Populations

P. Spala, chair: *Breeding experience with northern white rhinos*
J. Anderson: *Management of translocated white rhino in Southern Africa*
C. Furley: *The management of black and Sumatran rhinos at Port Lympne Zoopark, U.K.*
E. Reece: *Captive breeding of rhinoceroses in North America*
R. Rieches: *Rhinoceros breeding at the San Diego Wild Animal Park*

Some aspects of captive breeding of black, white, Indian and Sumatran rhino populations were discussed with the following results:

1) None of the captive rhino programs have so far reached the sustaining level.

2) The southern white rhino groups have not proved to be growing at expected rate. The other SSPs for rhinos are progressing satisfactorily.

3) Fulfillment of required population size objectives will require a doubling of available space.

4) Disease factors appear more prominent in browsing species (i.e., black rhino) than in grazing ones.

5) More research in reproduction, genetics, behavior, nutrition, etc., is necessary to achieve self-sustaining populations.

6) Managed populations of the translocated white rhinos in Southern Africa are doing well and are currently producing surplus at the rate of 10% per year.

Plenary V - Summary
Endocrinology and Reproduction

J.K. Hodges, chair: *Studies in rhinoceros reproductive endocrinology*
N. Czekala: *Salivary hormone analysis for black rhino pregnancy detection*
R. Godfrey: Progress in reproductive physiology research in rhinoceros
J. Hindle: *Recent advances in reproductive monitoring of rhinos in captivity and in the wild*
N. Schaffer: *Reproductive ultrasound and semen collection in chute-restrained cognizant rhinoceroses*

The aim of the session was to provide a brief account of current status in the field of reproductive physiology and to examine priorities for future studies in relation to management/conservation needs. Keith Hodges provided some background on the importance of monitoring methods, different approaches and potential applications. Jo Hindle highlighted the species differences hormone metabolism and their implication for methods of urinary hormone analysis. She presented data describing the pattern of excretion of 20α-dihydroprogesterone (20α-HP) and conjugated estrogens, allowing for the first time the monitoring of follicular development and corpus luteum function in African rhinos. An alternative method of monitoring based on hormone analysis of saliva was described by Nancy Czekala. The measurement of 20α-HP and estrogens in saliva should be useful in pregnancy diagnosis and prediction of parturition in the black rhino. Data on circulating levels of estradiol and progesterone during the ovarian cycle in a black rhino were presented by Rob Godfrey, showing that animals may be trained to use a squeeze chute for non-stressful blood sampling. He also reported that ovarian follicles, a corpus luteum and an early embryo had been visualized in using ultrasound. Nan Schaffer summarized her work on ultrasound and reproductive tract gross anatomy. The finding of a convoluted cervix may cause difficulties when attempting intra-uterine insemination. She also reported that viable semen had been collected from epididymes and by electrical and manual stimulation from Indian and African rhinos.

The value of assisted reproductive technologies (A.I., embryo transfer) to rhino management was discussed. Potential was clearly seen for captive animals. However, much more work was needed and any real impact on rhino conservation is unlikely within the next five years.

Priorities for the future.

1. Confirm endocrine data for ovarian cycle in African rhinos. More cycles from more animals are needed (especially white).

2. Correlate urinary data with blood samples and ultrasound. Focus on timing of ovulation and assessment of luteal function.

3. Greater precision is required for hormonal profiles during (early) pregnancy. The range of normal values for urinary and salivary hormones needs to be established.

4. Alternative methods of early pregnancy diagnosis need to be sought.

5. Method of pregnancy diagnosis from 1 or 2 samples needs to be developed to facilitate use on free-ranging animals.

6. Use of faecal hormone analysis for pregnancy detection should be pursued (due to potential for use with wild animals).

7. Wherever possible squeeze chute (crush) facilities should be installed and animals conditioned to regular handling.

8. Methods for ovarian stimulation and synchronization of ovulation need to be established. Different approaches, doses, treatment protocols and responses all need to be worked out.

9. Success rate for semen collection needs to be improved. Further work is needed to establish optimal semen freezing and storage methods. Procedures and instrumentation for A.I. need to be developed.

10. Placental material (particularly early pregnancy) should be collected and stored for structural, histological and endocrine evaluation.

Plenary VI - Summary
Biology and Conservation of Sumatran and Javan Rhinos

Mohd. Khan, chair: *Conservation planning for the Sumatran rhinoceros*
C. Santiapillai: *Conservation and management of Javan rhino (Rhinoceros sondaicus) in Vietnam*
K. MacKinnon: *Conservation and management of Sumatran Rhino (Dicerorhinus sumatrensis) in Indonesia*
Sukianto Lusli: *The status of Sumatran Rhino Rescue Programme in Indonesia*
Widodo Ramono: *Conservation and management of Javan rhino (Rhinoceros sondaicus) in Indonesia*
Linda Prasetyo: *Sumatran rhino (Dicerorhinus sumatrensis) captive propagation in relation to its conservation*

(Plenary session summary not available at this time)

Indonesian Rhino Conservation Informal Meeting

An informal meeting was conducted to exchange information and ideas relative to rhino conservation in Indonesia.

In particular, the group discussed plans and preparations for the Indonesia Rhino Conservation Workshop that had been postponed last January and is now to occur 3-5 October 1991 in Bogor, Indonesia. The draft agenda for this Workshop was reviewed and revised. Major items on the agenda include a review of the PVA process for Javan rhino, the Global Heritage Species Programme proposal for Sumatran Rhino, and the Indonesian Rhino Conservation Action Plan. Also reviewed was the Briefing Book being prepared for this Workshop. Numerous recommendations and materials were submitted for addition.

Also distributed and discussed were:

The latest draft Studbook for Sumatran Rhino including more refined analyses of the mortality that has occurred during the program.

The second draft of the Prototype Action Plan for Sumatran Rhino as a Global Heritage Species Programme.

Further PVA Analyses using VORTEX software from R. Lacy as well as an alternative approach developed by H. Prins. Directions for additional analyses before the October Workshop were explored.

The meeting concluded with an agreement by those attending to continue dialogue in preparation for the October Workshop to maximize the productivity of that meeting.

Summary of Global Propagation Group Meeting - Sumatran Rhino

The first meeting of the Global Propagation Group for the Sumatran Rhino was convened in conjunction with the International Rhino Conference in San Diego. In attendance were representatives of the 4 countries and 8 of 11 facilities maintaining captive specimens.

The purpose of the session was to review and advance the captive propagation program as part of the conservation strategy and action plan for this species. Studbook Keeper Foose presented a summary of the program since 1984.

31 (12/19) rhino have been captured in the 3 regions where rescue operations are being conducted: Indonesia 15 (6/9); Peninsular Malaysia 11 (2/9); Sabah 5 (4/1).

9 (4/5) rhino have died from a variety of causes which were reviewed; mortality has been differential in the various regions and facilities; death rates have declined over history of the program; last death occurred in 1989.

One animal has been born in captivity although conceived in the wild.

23 (8/15) rhino are alive in captivity today in 3 countries and 11 facilities: Indonesia 7 (3/4) rhino at 4 sites; Peninsular Malaysia 7 rhino (1/6) at 2 sites; Sabah 3 (2/1) rhino at 1 site; U.K. 2 rhino (1/1) at 1 sites.

Reproduction has been impeded by death of mature males.

An institution and animal by animal review of the captive population was conducted. Representatives of the 3 regions described their plans to optimize reproductive opportunities for rhino. Breeding activity was described in the U.K. and Jakarta where apparently full copulations have been observed. Plans were discussed to place male with females on regular basis in new Sungai Dusun Rhino facility in Peninsular Malaysia which will also now resume attempts to capture additional rhino especially males. U.S. representatives discussed plans to place all 3 females with the available male over next year.

Parties agreed to intensify efforts to investigate subspecies distinctions among rhino from different regions to guide reproductive programs. Amato offered his laboratory without qualification for this effort. A research working group was also organized to facilitate and improve cooperation and coordination among scientists in the several countries.

Finally, a prototype proposal to employ the species as an umbrella and perhaps Heritage Species was presented.

Parties agreed to continue dialogue and collaborations at October Rhino Workshop in Indonesia.

Plenary VII - Summary
Strategic Planning for Rhinoceros Conservation

R. Martin, chair: *Development of the Zimbabwe national conservation strategy for black rhinoceros*
T.J. Foose: *Global management of rhinos*
N. Leader-Williams: *Theory and pragmatism in the conservation of rhinos*

All these papers recognized a average minimum recurrent cost of US $200/sq. km. to conserve wild rhinos *in situ*. Martin showed data which indicated that this could rise to $400/sq km under conditions pertaining in Zimbabwe. Foose used these figures to estimate *in situ* conservation costs for viable populations of all taxa of rhino at $20-40 million per year.

All three speakers agreed that it was necessary to meet threshold funding (and manpower) levels to prevent failure of *in situ* conservation efforts. With current funds available for conservation this inevitably implies a departure from attempts to conserve rhinos in very large areas and an emphasis on smaller units dictated by budgets. Programs in Zimbabwe and other countries have incorporated this feature by focussing additional manpower in designated zones to protect large wild populations.

Thereafter there was some divergence of opinion among the speakers on the most effective approach for conservation action. In his presentation of a global strategy, Foose placed emphasis on the conservation biology aspects of rhino populations which were either dangerously close to or below viable population levels. He saw the future for rhinos lying in managed metapopulations consisting of *in situ* subpopulations and *ex situ* captive breeding subpopulations between which controlled movement of breeding animals would be necessary to maintain genetic diversity and demographic security. Highest priority should be placed on increasing both wild and captive bred populations immediately to escape deleterious stochastic threats. Foose felt that the situation had reached a stage where it was undesirable that any taxa of rhino should be reliant on a single political authority for its survival. While advocating the value of captive breeding programs, Foose observed the need for improvement in husbandry.

Leader-Williams presented a powerful case that the <u>only</u> effective conservation of rhinos to date had occurred *in situ* in areas where adequate budgets and manpower had been provided. He presented data to show that, to date, the contribution of *ex situ* captive breeding programmes to conservation of rhinos (and several other species) had been negligible and costly. He expressed caution at experimenting with captive breeding at a stage when many populations needed immediately to be increased to more secure levels.

Martin, also, felt that *in situ* protection of rhinos was of the utmost priority. He highlighted the fact that adequate budgets for such efforts could be obtained sustainably within the three southern African countries which now contain over 90% of Africa's black and white rhinos by taking advantage of the inherent economic value of rhino. A controlled trade in legal government stocks of rhino horn and/or the raising of revenues from a small quota of animals for sport hunting could provide the necessary funds. Current contributions to rhino conservation from the international community were small compared to the budgets allocated by those African governments who had achieved successful conservation of rhino, and these governments sought to remain self-sufficient in funding through sustainable conservation measures. Zimbabwe had made a secondary commitment to *ex situ* captive breeding by its intent to provide a viable founder population of black rhino. It saw this as an ultimate form of insurance in the very long term against extinction possibilities but did not in any way view this as reducing the *in situ* conservation requirements.

In summary:

1. The paramount goal should be the maintenance or restoration of viable wild rhino populations.
2. More money needs to be directed toward this effort either by greater donor involvement or by sustainable utilization of the species including the use of its high economic value.
3. Captive propagation could offer an ultimate insurance against extinction provided that better husbandry, management and breeding performance can be achieved.

Plenary VIII - Summary and Working Group Report

Health, Disease, Nutrition and Pharmacology: Veterinary Aspects of Rhinocerus Conservation

E. Miller, chair: *Health concerns and veterinary research in the North American black rhinoceros* (Diceros bicornis) *population*
C. Furley: *Diseases and management of black and Sumatran rhinoceroses at the Howletts and Port Lympne zoos*
L. Geldenhuys: *Capture and translocation of black rhino in Namibia*
D. Jessup: *Health data gained from black rhinoceroses immobilized for relocation*
M. Kock: *Capture and translocation of the black rhinoceroses (Diceros bicornis) in Zimbabwe: Management modifications to reduce stress and mortalities*
R. Kock: *Veterinary management of three species of rhinoceroses in zoological collections*
R. Montali: *Pathological findings in captive rhinoceroses*
P. Morkel: *Translocation and dehorning of wild black rhinoceroses*
L. Munson: *Mucosal and cutaneous ulcerative syndrome in black rhinocerso (Diceros bicornis)*

In view of the role that health and nutritional problems in the maintenance of captive rhinoceros populations (eg. as a limiting factor in the growth of the captive black rhinoceros population), and that they have presented concerns in wild populations and their translocations, the following points for consideration and action are recommended:

1. Continued investigation of health problems in wild and captive rhinoceroses. New and continued research should be organized and encouraged in the following areas:

   All morbidity and mortality data from captive, and where possible, wild populations should be compiled and reviewed annually under the auspices of the regional species management plans and national wildlife programs, and those regional data reviewed under the auspices of the IUCN/CBSG Rhinoceros Action Plan. Such studies should include evaluation of post-capture and post-translocation mortalities.

   Investigation of fertility and the incidence and prevention of management related disease and trauma.

   Additionally, monitoring the fertility of all rhinoceros populations with particular attention to fertility in Indian rhinoceroses and abortion rates in black rhinoceroses.

   Enhancement of baseline data for normal values from free-ranging and captive rhinoceroses of all species is of critical importance to all fields of research.

   Epidemiology of health problems in captive and wild rhinoceros populations and comparison of patterns in each. Such research should include seroprevalence surveys for infectious diseases and evaluation of internal and external parasites and their health significance.

   Continued sharing and refinement of immobilization regimens between wildlife and zoo veterinarians should take place. Narcotic agents (etorphine and carfentanil) are the primary drugs used for immobilization, and further investigations are needed to establish preferable supplemental tranquilizers, particularly long-acting neuroleptic agents.

Metabolic consequences of anesthesia and the stresses associated with capture and the sequelae of both should be assessed.

Studies to address the immunocompetency of wild and captive black rhinoceroses and the role that immunology may play in several of their diseases, eg, fungal pneumonia of black rhinoceroses.

Nutritional research should include general review of the feeding practices used in all species in captivity with particular attention to minimal requirements. Basic nutritional evaluations should focus attention on both the nutrition of wild and captive populations. Research to establish effective dietary supplementation with α-tocopherol should be encouraged.

In black rhinoceroses further research should be designed to evaluate the following diseases and syndromes:

Hemolytic anemia - Current recommendations for the prevention of acute hemolytic anemia include vaccination of captive animals with a bacterin containing 5 leptospiral serovars. Research to an underlying cause for the hemolysis should continue.

Oral/skin ulcers

Further evaluation of iron metabolism due to the accumulation of hepatic iron in captive and newly captured black rhinoceroses.

Fungal pneumonia

Encephalomalacia

2. In conjunction with the above proposals, identification of additional funding resources to support health research in rhinoceroses is vital.

3. Continued maintenance and enhanced participation in regional biomaterial banks (tissue, sera, urine, etc) with materials from both captive and wild rhinoceroses of all available species is vital to future comparative studies.

4. Continued and enhanced collection of genetic samples from anesthetized animals whenever possible.

5. Continued and improved communication between veterinarians working with both wild and captive rhinoceroses should be enhanced through future meetings. Special effort should be applied to the maintenance of continuous medical histories for rhinoceroses translocated from the wild to captivity.

In summary, there should be veterinary participation in the management of captive and wild rhinoceros populations. This participation should be an integral part of a multidisciplinary approach to their care, and is particularly relevant to their capture and translocation. Such efforts will contribute to the long term survival of both *in situ* and *ex situ* rhinoceros populations.

Planning for Rhinoceros Conservation

Proposed consensus items and/or issues for discussion and clarification:

1) There should be a greater flow of funds from international development agencies to projects that conserve biological diversity.

2) There is a need for increased flow of information concerning the costs of *ex situ* and *in situ* conservation.

3) There is a need for more accurate and timely reporting of data concerning population abundance, especially for *in situ* populations of black, Sumatran and Javan rhino.

4) Civil and military conflicts within and between nations pose a proximate threat to rhino populations. Demographic vulnerability due to small population size poses the most immediate threat to wild populations of rhinos where poaching activities are under control and where negative civil and military impacts on rhino populations are precluded.

5) A closer examination of husbandry regimes for rhinos in zoological parks is warranted in order to gain insights into their apparently less-than-maximal reproduction rates.

6) Non-invasive reproductive monitoring of rhinos in zoological parks should be expanded and, as possible, compared with data obtained from *in situ* sanctuary and *ex situ* sanctuary populations of rhinos.

7) The development of a simple pregnancy test, especially one that could be employed under field conditions would be of use in both *in situ* and *ex situ* management of rhinos.

8) It is worthwhile at this time to conduct experiments in the introduction of black rhinos into existing populations. The existing populations should be derived from demographically and genetically secure sources so that their reproduction is not considered essential for meeting gene pool conservation goals in the region. The introduced rhinos could include individuals of either sex and be derived from zoological parks or *in situ* populations. (i.e., it is valuable now to begin to develop successful approaches for the creation of metapopulations).

9) A Second International Conference on Rhinoceros Biology and Conservation is warranted as in three years' time new information on disease, reproduction and the development of sanctuary programs is anticipated.

Working Group Report
Conservation of the Northern white rhinoceros

Ceratotherium simum cottoni

At the International Conference on Rhinoceros Biology and Conservation the most recent information available was exchanged. A Northern white rhinoceros working group met and presented their report at a conference plenary session.

Recommendations are made in three areas: conservation of the *in situ* population, conservation of the *ex situ* population, and coordination of these efforts.

In situ population

The success of the conservation efforts for the Northern white rhinoceros in Garamba National Park taken by the government of Zaire is recognized and those responsible are to be commended for their actions.

Continuation or increase in the levels of international funding for the Garamba ecosystem and an increase in the level of research efforts in support of the Northern white rhinoceros is recommended.

External assistance is recommended for the further training of park staff in techniques of wildlife protection.

Further research should be undertaken on nutrition and feeding ecology. Research should also be undertaken on the genetic status of the Garamba population. Collection of samples for genetic analyses, including examination of the levels of genetic diversity and in methods of parentage determination, should be encouraged. Research should be initiated on the role of infrasonic vocalizations in communication between and among individual rhinos in the park.

Research findings on the rhinos in Garamba Park can usefully support investigations into reproductive efficiency of the captive population and *vice versa*. The detection of pregnancy, especially of the early stages of pregnancy, would have useful application to the Garamba Northern white rhinoceros.

Ex situ population

Recommended is the aggressive investigation of the estrus cycles and continuous monitoring of all captive females (except those less than 5 years of age). Monitoring of salivary and/or urinary 20α DHP and estrogen conjugates is recommended.

Semen collection and freezing from all males should be undertaken.

A technical working group should be convened to discuss the options and protocols for the most appropriate action to be undertaken in order to increase the reproductive potential of the *ex situ* population.

The feasibility of induction and/or synchronization of estrus should be investigated using female Southern white rhinos.

All zoological parks maintaining Northern white rhinoceros should immediately construct and install manipulation chutes that allow for the safe handling of animals for reproductive examinations and other necessary veterinary investigations. Plans are available for these manipulation chutes.

The zoological parks that hold the Northern white rhinoceros have a critical responsibility for these animals and their potential contribution to the gene pool. The activities of these institutions should be monitored by the IUCN Captive Breeding Specialist Group. The individual rhinos removed from the wild provide a crucial source of gene pool resources that are of potential benefit in the future of the wild population.

No further transfers of Northern white rhinoceros from the Zoo Dvur Kralove is recommended at this time. The collection of a breeding nucleus of the Northern white rhinoceros and its husbandry at Dvur Kralove enable the option of utilizing an *ex situ* population in support of the population in the wild and the ecosystem in which it exists.

Coordination of efforts for *in situ* and *ex situ* conservation

More frequent and detailed communication of data and research conclusions is recommended. Detailed summaries of information relevant to reproduction and population management should be exchanged between all parties.

The opportunities for cooperation and linkage of aspects of the management of the gene pool resources is recognized by all parties and efforts to develop appropriate approaches to linking *in situ* and *ex situ* populations should be explored.

CURRENT RHINO POPULATIONS AND DISTRIBUTION

Introduction - The following represents the most current data available on rhinoceros populations and their distribution. It was collected by personal interview, conference presentations and related materials gathered at the International Symposium on Rhinoceros Biology and Conservation held May 9 through May 11 in San Diego, California, USA.

Northern White Rhinoceros - the Northern White rhinoceros (*Ceratotherium simum cottoni*) currently exists in the wild only in Garamba National Park, Zaire. The population there consists of 15 males and 13 females (K.H. Smith, 1991); six of these males and twelve of the females form the actively breeding portion of the population.

The captive population resides in two institutions: Vychodoceska Zoo in Dvur Kralove, Czechoslovakia and the Wild Animal Park in San Diego, USA. The Vychodoceska Zoo has two males and five females. One of the females is a Northern White/Southern White hybrid (P. Spala 1991). The Wild Animal Park has two males and two females in its herd.

Southern White Rhinoceros - the status of the Southern White rhinoceros *Ceratotherium simum simum* in the wild over the past decade is as follows (from C.G. Gakahu, 1991 and with revisions):

	1980	1984	1990
Botswana:	70	200	15
CAR:	20	1	0
Kenya:	25	30	65
Mozambique:	30	20	0
Namibia:	150	70	200
South Africa:	2300	3330	4225
Swaziland:	60	60	8
Zambia:	5	10	6
Zimbabwe:	180	200	200
	3841	3947	4745

The captive population consists of 698 individuals (342 males, 355 females one undetermined) in 245 institutions according to the 1991 African Rhino Studbook.

Black Rhinoceros - the status of the Black rhinoceros (*Diceros bicornis*) in the wild over the past decade is as follows (from C.G. Gakahu, 1991):

	1980	1984	1987	1990
Angola:	300	90	0	0
Botswana:	30	10	10	2
Cameroon:	110	110	25	15
CAR:	3000	170	10	0
Chad:	25	5	5	2
Ethiopia:	20	10	0	6
Kenya:	1500	550	520	400
Malawi:	40	20	25	5
Mozambique:	250	130	0	0
Namibia:	300	400	470	400
Rwanda:	30	15	15	9
Somalia:	300	90	0	0
South Africa:	630	640	580	626
Sudan:	300	100	3	0
Swaziland:	0	0	0	1
Tanzania:	3795	3130	270	185
Uganda:	5	0	0	0
Zambia:	2750	1650	110	40
Zimbabwe:	1400	1680	1760	1700
	14,785	8800	3803	3392

The captive population, according to the 1991 African Rhino Studbook, consists of 91 males and 113 females (204 total animals) in 72 institutions.

<u>Greater One-Horned Rhinoceros</u> - the Greater One-Horned rhinoceros (*Rhinoceros unicornis*) is known in the wild in the following locations (from the Action Plan: Asian Rhino Specialist Group (1989), Dinerstein (1991), Sinha (1991)):

INDIA-	
Manas (Bhutan border):	60
Dudwa:	9
Kaziranga:	1080
Laokhowa:	5
Orang:	65
Pobitora:	40
Pockets in Assam:	25
Pockets in West Bengal:	32
NEPAL-	
Royal Bardia:	38
Royal Chitwan:	358
PAKISTAN -	
Lal Sohanra:	?
TOTAL =	1712

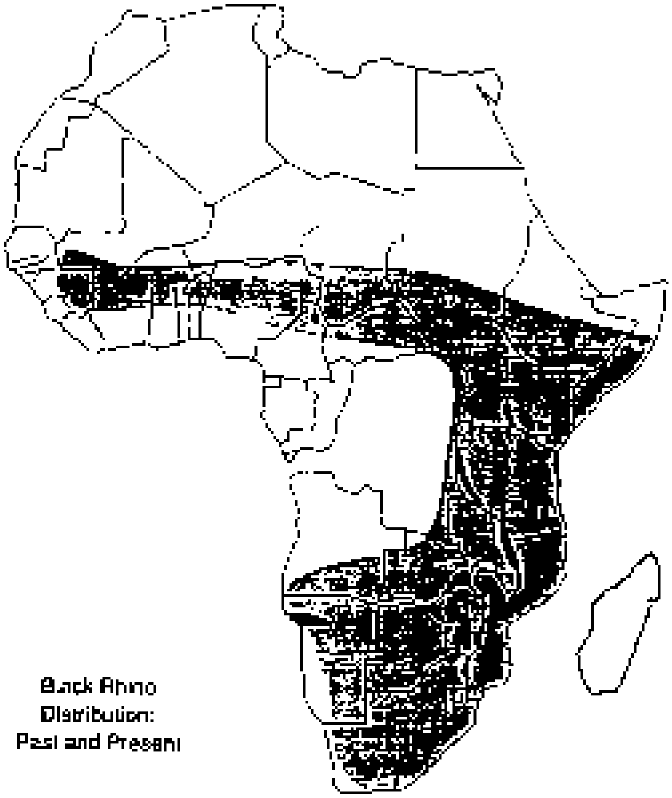
The captive population currently consists of 67 males and 47 females (114 total individuals) in 43 institutions.

<u>Javan Rhinoceros</u> - there are between 52 and 62 Javan rhinos (*Rhinoceros sondaicus*) currently in Ujung Kulon, Java, Indonesia (Ramono, 1991). The Vietnamese population is estimated at 8 to 12 individuals (Santiapilli, 1991) in the area where the Song Be, Lam Dong, Dong Nai and Dac Lac regions meet.

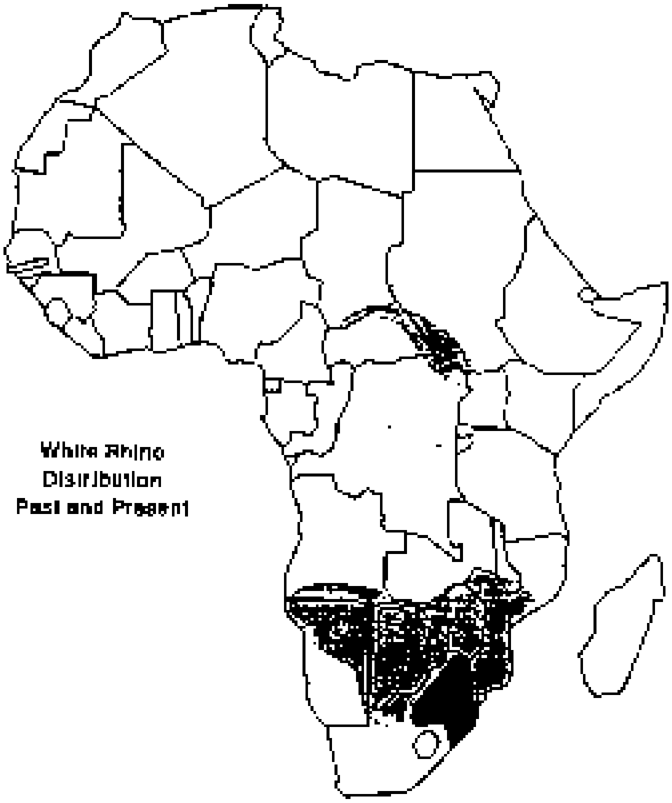
<u>Sumatran Rhinoceros</u> - *Dicerorhinus sumatrensis* is distributed in the following areas in Southeast Asia (Khan, 1989 & 1991):

BURMA -	
Schwe-u-daung:	?
Tamanthi:	?
Burma:	6-7
INDONESIAN BORNEO (Kalimantan)	
near Sabah border:	30
SUMATRA, INDONESIA-	
Gunung Leuser:	130-200
Gunung Patah:	?
Kerinci Seblat:	250-500
Gunung Abong-abong & Lesten-Lukup:	15-25
Berbak:	?
Torgamba:	?
Barisan Selatan:	25-60
PENINSULAR MALAYSIA -	
Endau Rompin:	10-25
Taman Negara:	26-40
Sungai Dusun:	3-4
Gunung Belumut:	3-5
Mersing Coast:	5-6
Sungai Depak:	2-4
Sungai Yong:	3-5
Kuala Balah:	2-4
Bukit Gebok:	2
Krau Reserve:	1
Sungai Lepar:	2
Ulu Atok:	1
Ulu Selama:	11
Ulu Belum:	2-4
Bubu Forest:	2
Kedah:	5
Between Ulu Selama & Kedah:	2-3
MALAYSIAN BORNEO-	
Tabin Reserve, Sabah:	20+
Kretam/Dent Peninsula, Sabah:	8
Danum Valley, Sabah:	10
Limbang, Sarawak:	13
THAILAND-	
Phu Khieo:	?
Tenasserim Range:	6-15
Khao Soi Dao Reserve:	?
TOTAL =	595-1012

The captive population currently stands at 19 rhinos (6 males and 13 females) in 9 institutions and two (one male, one female) at the Ipoh capture site (Draft Sumatran Rhino Studbook, 1991).

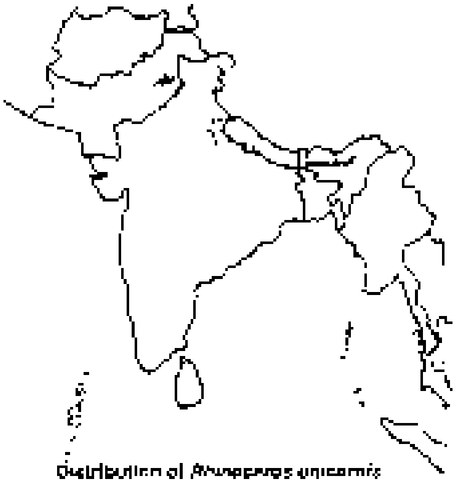


Black Rhino
Distribution:
Past and Present



White Rhino
Distribution
Past and Present

DISTRIBUTION OF SUMATRAN RHINOS
PAST AND PRESENT



Distribution of *Rhinoceros unicornis*
Past and Present

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RHINO GLOBAL CAPTIVE ACTION PLAN WORKSHOP

BRIEFING BOOK

LONDON ZOOLOGICAL GARDENS
9-10 MAY 1992

SECTION 21

GLOBAL HERITAGE SPECIES PROGRAMME

Sumatran Rhinoceros

Dicerorhinus sumatrensis

Global Heritage Species Program

Conservation Action Plan Prototype

DRAFT 2
1 May 1991

IUCN/SSC
Captive Breeding Specialist Group
in collaboration with
Asian Rhino Specialist Group
PHPA- Indonesia
DWNP- Malaysia

CBSG

INTRODUCTION

The concept of a Global Heritage Species Program (GHSP) originated in 1988. The idea is to carefully select a group of ecologically significant, culturally important, and publicly charismatic species that can be used as flagship and umbrella taxa to attract support for conservation not only of the species themselves but also their ecosystems. Since then, GHSP has been the subject of much discussion and development. An important component that has been emphasized during preliminary development has been the need to base Global Heritage Species Programs on biologically sound conservation action plans.

In April 1990, the Captive Breeding Specialist Group (CBSG) was invited by the Chairman of the IUCN Species Survival Commission (SSC) to lead preparation of one or two proposals for conservation action plans that could be used as prototypes for GHSP. Criteria considered to select candidates for prototype development included:

(1) Candidates should be both umbrella and flagship taxa;
(2) They should be taxa for which there is already considerable background and foundation, including population viability assessments, for this kind of program;
(3) Hence, they should be taxa for which explicit and preferably quantitative goals and objectives can be formulated;
(4) They should be taxa whose survival definitely depends on both *in situ* protection/management and captive propagation so that both the field and zoo communities can be actively involved.

CBSG immediately proposed the Sumatran rhino (*Dicerorhinus sumatrensis*) as a species which eminently satisfied these criteria. A first draft of a GHSP conservation action plan prototype employing Sumatran rhino was prepared in October 1991 by the CBSG. This draft plan was based closely on the Asian Rhino Specialist Group Action Plan (Khan 1989)

Naturally, development of these types of conservation action plans must be collaborative endeavors with scientists and managers in the range states. Therefore, this document was only a skeleton of a prototype conservation action plan for the Sumatran rhino. During November 1990, CBSG Executive Officer Foose consulted with wildlife officials in Indonesia and Malaysia to add flesh to the skeleton.

The skeletal proposal with some enhancements was presented at the IUCN SSC meetings in Perth, Australia 24-27 November 1991 by representatives of CBSG, the Asian Rhino Specialist Group, the Department of Forest Protection and Nature Conservation of Indonesia (PHPA), and the Department of Wildlife and National Parks (DWNP) of Malaysia. At Perth, the Steering Committee of the SSC encouraged further development of the prototype, especially at and through the Indonesian Rhino Conservation Workshop now proposed for Bogor, Indonesia 3-5 October 1991. The objective is a full proposal for a prototype action plan for presentation to SSC Steering Committee.

BIOLOGICAL PREMISES, GOALS, DESIDERATA

- Ideally, there should be linkage between the taxa selected for the Global Heritage Species Program and some strategic designation of the natural parts of the planet. In other words, there should be an attempt to preserve what might be generically referred to as "heritage areas" - with an explicit target, e.g. perhaps 10% of the natural areas of the planet with as much representation as possible of its ecosystems diversity.

- Therefore, the GHSP should select not only flagship (charismatic) species but also umbrella species, i.e. taxa for which the habitat required to sustain viable populations is sufficiently large to encompass appreciable parts of natural ecosystems.

- Further, GHSP candidates should be selected in such a way that the smallest number of taxa will encompass the greatest fraction of the natural areas of the planet. (As a consequence, megavertebrates may have preference; fortuitously, they may also be the most charismatic and hence desirable in terms of promoting the program).

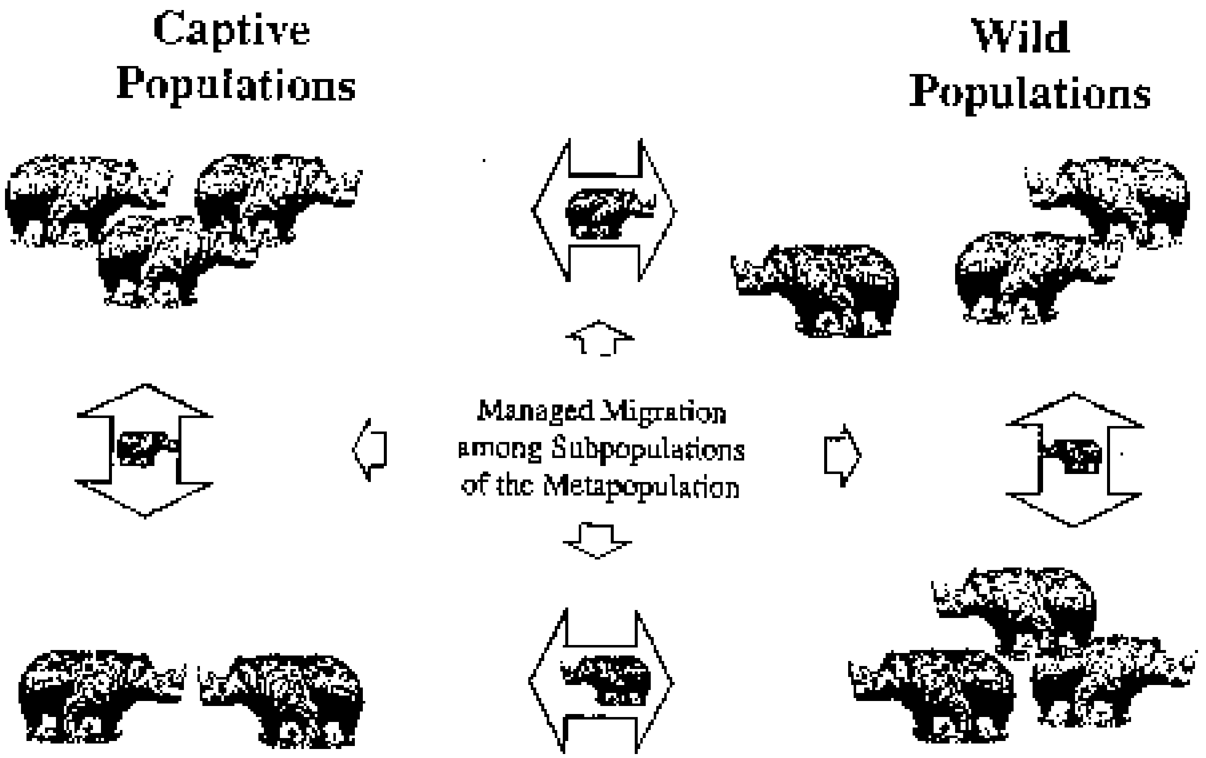
- For each heritage species, a conservation action plan must be developed based on population viability assessment and conservation biology principles.

- Many if not most candidates for GHSP will be characterized by small populations and as such will be vulnerable to stochastic problems that can endanger survival just as much as can the more deterministic threats of habitat degradation and unsustainable exploitation. Environmentally, small populations can be devastated by catastrophes or decimated by less drastic fluctuations in the environment. Demographically, small populations can be disrupted by random failures in survivorship and fertility. Genetically, small populations lose heritable diversity needed for fitness and adaptability. The smaller and more fragmented the population, the greater these problems are and the more likely extinction is to occur.

  Protecting endangered species from these problems entails development of populations that are sufficiently large and well distributed to survive the stochastic risks, i.e. intensively and interactively managed metapopulations that frequently have ex *situ* programs to reinforce *in situ* efforts. (Figure 1).

FIGURE 1

Metapopulation



- As a consequence, the conservation action plan should have specific quantitative objectives as countermeasures to the stochastic problems, e.g.
    - Insure 99% probability of survival and 95% preservation of diversity for next 100 years
    - Sustain 99% probability of survival and achieve recovery of evolutionary potential by end of next 100 years
    - Consequently, attain and maintain populations of quantitatively specified size and distribution to achieve these objectives.
- Performance toward achieving objectives should be measurable. This desideratum will be greatly facilitated if the objectives are quantitative.
- The action plans should be organized with modularized components and budgets, to facilitate implementation, funding, and evaluation.

GENERAL BACKGROUND ON SPECIES

- The Sumatran rhinoceros is a species of the South East Asian rainforest.

- The species was formerly distributed over much of South East Asia from eastern India through Myanmar (Burma), Thailand, peninsular Malaysia, and the islands of Sumatra and Borneo.

- The current and former distribution (and therefore the historic range that might be recovered) is depicted in Figure 2.

- The population is greatly reduced and fragmented. Approximately 500 to 1000 rhino are estimated to survive in 35 or more localities throughout South East Asia. The most significant known populations survive in Indonesia and Malaysia.

- The current distribution and estimated abundance as well as the potential carrying capacity of Sumatran rhino is presented in Table 1.

- Many of the individuals occur outside protected areas and viable populations (i.e. large enough to survive stochastic threats).

- Because numbers of the Sumatran rhino have become so reduced and fragmented, the species is subject to stochastic problems (environmental, demographic, and genetic) that can endanger its survival. (Khan 1989; Seal & Foose 1989).

- Three subspecies have been described for the Sumatran rhino:

  Dicerorhinus sumatrensis: Sumatra, peninsular Malaysia, Thailand

  Dicerorhinus sumatrensis harrisoni: Borneo

  Dicerorhinus sumatrensis lasiotis: Myanmar (Burma) and eastern India

  Additionally, the Asian Rhino Specialist Group has expressed concern that the populations on Sumatra may differ significantly from the populations in peninsular Malaysia and Thailand. Current descriptions of subspecies are based on non-genetic taxonomic methods. There has not been a rigorous analysis to determine if the described subspecies and or geographical varieties represent evolutionarily significant units that should be conserved as separate entities. Some research on molecular genetics of individuals from various regions is in progress.

- Among rhinos, the species seems particular attractive and charismatic being normally covered by a prominent coat of hair and exhibiting a very varied repertoire of vocalizations and behaviors.

DISTRIBUTION OF THE SUMATRAN RHINOCEROS
(*Dicerorhinus sumatrensis*)

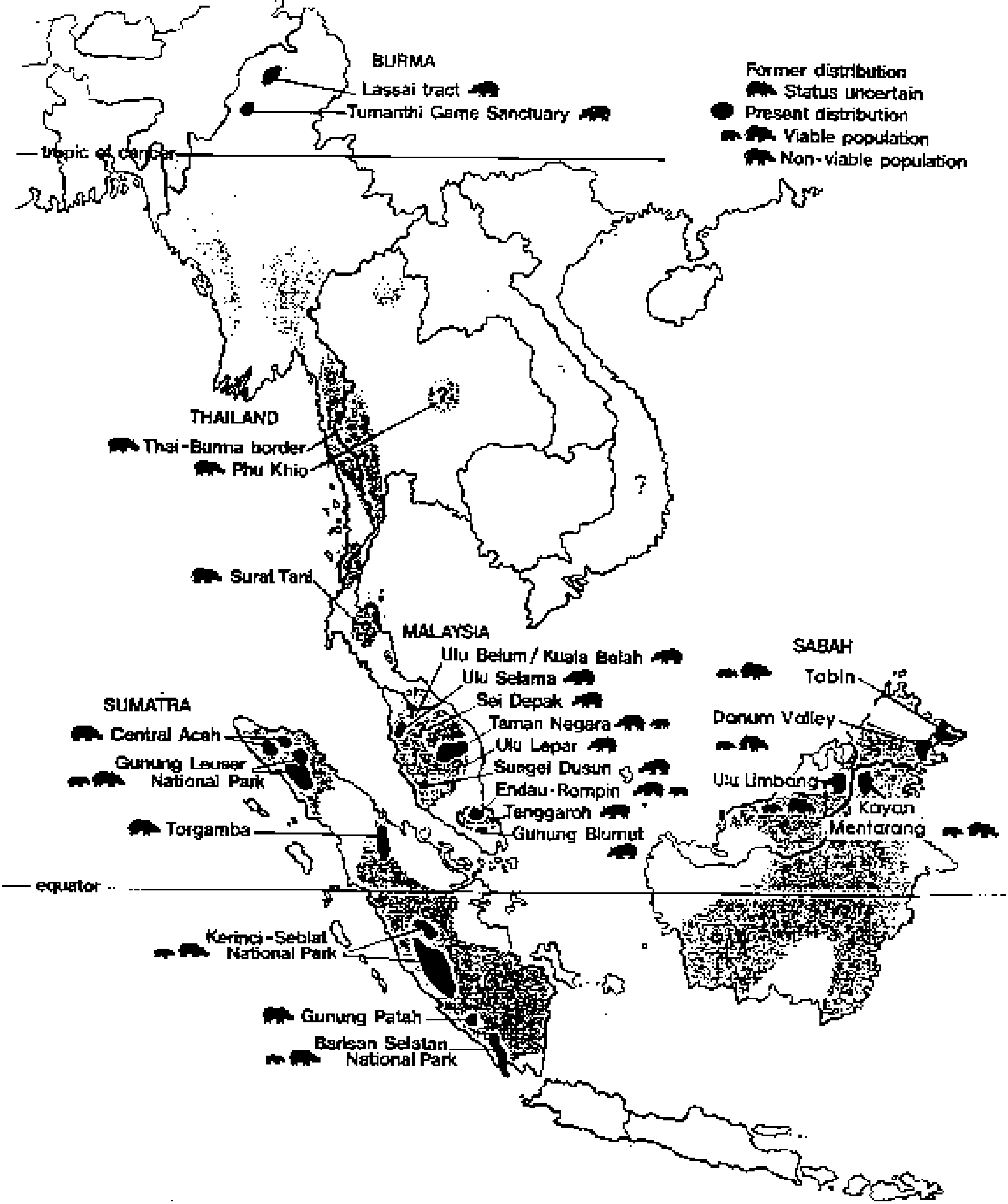


TABLE 1
DISTRIBUTION AND ABUNDANCE OF SUMATRAN RHINO
(From Khan 1989)

Country	Location	No. of Rhino	Habitat Availability		Protection Status	Potential Carrying Capacity
			Presently (Km^2)	Potentially (Km^2)		
Burma	Schwe-u-daung	Perhaps survives	217	?	Game sanctuary	?
Burma	Tamanthi	Perhaps survives	2,150	?	Game sanctuary	?
Burma	Lassai tract	6-7	?	?	Unknown	?
Indonesia (Kalimantan)	near Sabah border	Perhaps survives	?	?	Unclear	?
Indonesia (Sumatra)	Gunung Leuser	130-200	1 400	2,300	National Park but disturbance & poaching	140-800
Indonesia (Sumatra)	Gunung Patah	Numbers unknown	400	500	No information	40-50
Indonesia (Sumatra)	Kerinci Seblat	250-500	5,000	10,000	Little protection proposed National Park	500-1,000
Indonesia (Sumatra)	Gunung Abong-abong and Lesten-Lokop	15-25	?	?	Not protected	?
Indonesia (Sumatra)	Berbak	Perhaps exists	?	?	Nature Reserve	?
Indonesia (Sumatra)	Torgamba	Very few	?	?	Being deforested	?
Indonesia (Sumatra)	Barisan Selatan	25-60	700	3,600	National Park, deforestation occurring	70-360
Malaysia (Peninsula)	Endau-Rompin	10-25	1,600	1,000-1,600	Reserve, National Park proposed	110-160
Malaysia (Peninsula)	Taman Negara	22-36	4 400	4,400	National Park	220-440
Malaysia (Peninsula)	Sungai Dusun	3-4	40	140 +	State Wildlife Reserve	15
Malaysia (Peninsula)	Gunung Belumut	3-5	230	230	Wildlife Reserve proposed	23
Malaysia (Peninsula)	Mersing Coast	5-6	?	Probably none	Being deforested	0
Malaysia (Peninsula)	Sungai Depak	2-4	?	Probably none	Being deforested	0
Malaysia (Peninsula)	Sungai Yong	3-5	?	Probably none	No information	0
Malaysia (Peninsula)	Kuala Balah	2-4	?	Probably none	Being deforested	0
Malaysia (Peninsula)	Bukit Gebok	2	?	None	Being deforested	0
Malaysia (Peninsula)	Krau Reserve	1	500	500	Insecure	50
Malaysia (Peninsula)	Sungai Lepar	2	1,000	0	Unprotected and being deforested	0
Malaysia (Peninsula)	Ulu Atok	1	?	?	No information	?
Malaysia (Peninsula)	Ulu Selama	6-7	?	?	Unprotected	?
Malaysia (Peninsula)	Ulu Belum	2-4	?	?	Insecure	?
Malaysia (Peninsula)	Bubu Forest	2	?	?	No information	?
Malaysia (Peninsula)	Kedah	1	?	?	Insecure	?
Malaysia (Sabah)	Tabin Reserve	20+	1,200	1,200	Perhaps protectable	120
Malaysia (Sabah)	Kretam/Dent Peninsula	8	1,000	0	Being converted to agriculture	0
Malaysia (Sabah)	Danum Valley	10	2,000	2,000	Perhaps protectable	200
Malaysia (Sarawak)	Limbang	5-15	600	600	Protection proposed	60
Thailand	Phu Khieo	Perhaps survives	1,550	?	Protected area	?
Thailand	Tenasserim Range	6-15	?	?	Insecure	?
Thailand	Khao Soi Dao Reserve	Perhaps survives	745	?	Protected area	?
TOTAL			536-963			1,548-3,278

RANGE STATES COMMITMENT, RESOURCES, INFRASTRUCTURE

- An Action Plan has been formulated by the IUCN SSC Asian Rhino Specialist Group. This Plan has been based on preliminary population viability assessments for the species. The Plan has specific and quantitative objectives for conservation action on the Sumatran rhino.

- National conservation strategies for the Sumatran rhino are being developed in both of the currently major range states: Indonesia and Malaysia.

- The Indonesian strategy provides for 3 major types of activities: *in situ* protection and management employing both resident and mobile rhino units; translocations; captive propagation. An Indonesian Rhino Conservation Service has been proposed (Figure 3).

    - Activities and budgets to implement this Indonesian strategy are being formulated in modules.

    - Indonesia has organized an Indonesian Rhino Conservation Foundation to recruit support and coordinate activities for implementation of its rhino conservation strategy.

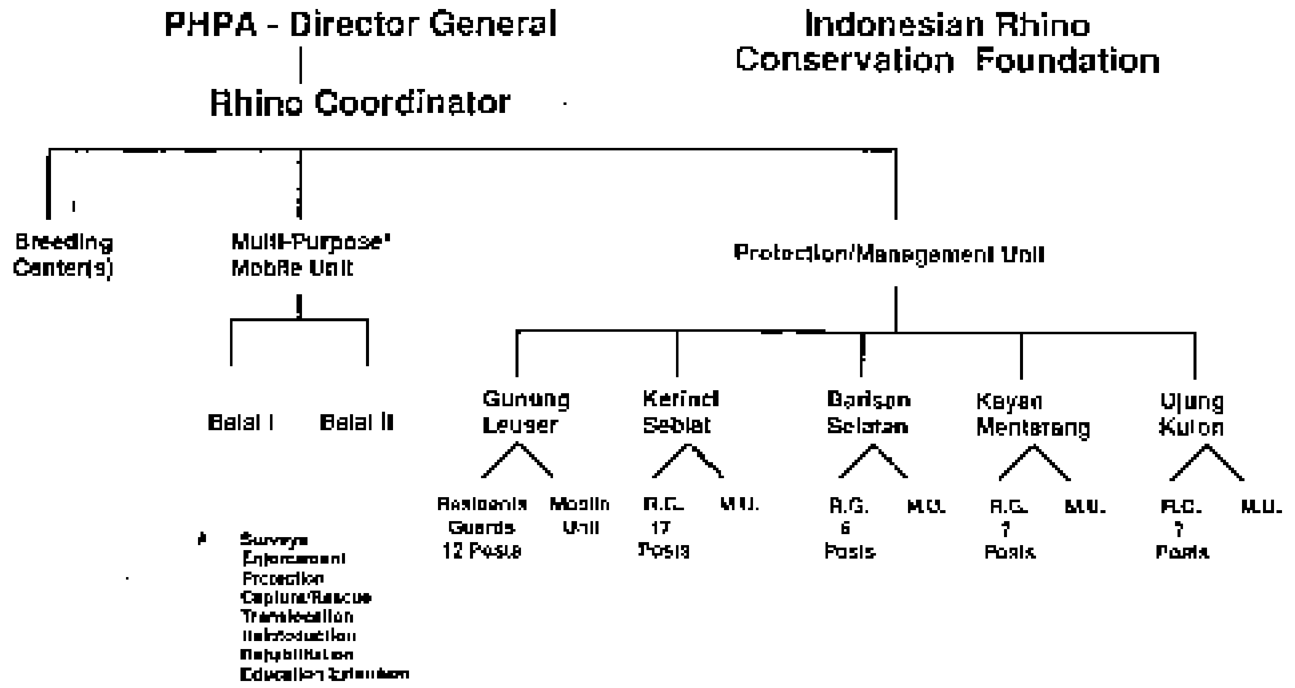
- Malaysia has already developed a very effective rhino unit for conservation of its rhinos. A similar kind of rhino unit is being contemplated for Indonesia.

- The Association of South East Asian Nations (ASEAN) provides the organizational infrastructure to facilitate multinational cooperation and coordination for conservation of this species.

- An Association of South East Asian Zoos has also been organized.

FIGURE 3
INDONESIAN RHINO CONSERVATION SERVICE

Tentative Organization of Indonesian Rhino Conservation Service



* Surveys
Enforcement
Protection
Capture/Rescue
Translocation
Reintroduction
Rehabilitation
Education Extension

BIOLOGICAL GOALS AND OBJECTIVES

- Preliminary population viability analyses for the Sumatran rhino recommend:

  - A total population of at least 2,000 to 3,000 to achieve an effective population size (N_e) of at least 500.

    Larger populations are desirable and may be necessary for viability if further studies validate each of the described subspecies and/or regional varieties as conservation units to be conserved separately.

  - Populations of 700-1000 in each of the major regions of the range Sumatra; Borneo; peninsular Malaysia; and Thailand; and Northern Myanmar (Burma)/eastern India.

  - Distribution of the total population over at least 6 major sanctuaries.

  - Each sanctuary capable of accommodating a minimum of 100 rhino. Preferably, at least 2 sanctuaries capable of accommodating at least 400-500 rhino.

- These recommendations provide for a 99% probability of survival relative to demographic and environmental stochasticity and an genetically effective population size of 500 which should maintain adequate genetic variation to permit the evolutionary process to continue if the disjunct populations are managed interactively and intensively as a metapopulation.

  Examples and results of Population Viability Analyses are presented in Appendix 1.

- Attaining and sustaining viable populations of these sizes will require at least 20,000 to 30,000 sq. km. of tropical forest habitat (based on estimates by Sumatran rhino researchers of carrying capacity of 1 rhino/10 km^2). Because not all habitat within protected areas will be appropriate for the rhino, actual area required for populations of these sizes is probably on the order of 40,000 to 60,000 km^2.

- Based on these analyses, The Action Plan of the IUCN SSC Asian Rhino Specialist Group recognizes 7, possibly 8, major existing sanctuaries and populations as viable for the Sumatran rhino. (Recent reports suggest a 9th viable situation may exist in Kayan Mentarang in Kalimantan.) The Action Plan recommends that field efforts at protection and management initially be concentrated on these sanctuaries. The major conservation action needed are anti-poaching activities and habitat protection, management, and rehabilitation.

For each sanctuary explicit quantitative objectives can be established for the minimum sizes of the populations to be sustained and thus the area of natural habitat to be protected and managed:

Country	Sanctuary	Area (km^2)	Current Population	Target Population
Indonesia	Gunung Leuser	8,000	130-200	400
	Kerinci Seblat	10,000	250-500	500
	Barisan Selatan	3,600	25-60	100
	Kayan Mentarang	16,000	Some	500
Malaysia				
Peninsula	Endau Rompin	1,600	10-25	100
	Taman Negara	4,400	22-36	200
Sabah	Tabin	1,200	20+	100
	Danum Valley	2,000	10	100
Sarawak	Ulu Limbang	1,000 *	5-15	100

* Will require enlargement of protected area from current 600 km^2

These 7-9 sanctuaries contain much biological diversity that will also be conserved by protection/management actions implemented for the Sumatran rhino. (All are accorded "A" Priority by MacKinnon & MacKinnon (1986).

Sanctuary	Area	Mammals	Birds	Herps	Invertebrates	Plants

Information to be provided from species lists compiled by each country involved.

- Additionally, the Sumatran rhino formerly occurred (and perhaps still precariously survives) in other major sanctuaries to which the species could be restored by recolonization from captive propagation or translocations.

Country	Sanctuary	Area (km^2)	Current Population	Target Population
Indonesia				
Kalimantan	Kutai	2,000	0	
Malaysia				
Peninsula	Krau Reserve	500	1	50
Thailand	Phu Khieo	1,500	0	100
	Khao Soi Dao	750	0	50
Myanmar (Burma)				

- These sanctuaries also contain much other biotic diversity that could and would be conserved by protection/management actions implemented for the Sumatran rhino.

Sanctuary	Area	Mammals	Birds	Herps	Invertebrates	Plants

Information to be provided from species lists compiled by each country involved.

- The Action Plan also recommends development of a captive population of at least 150-225 rhino, depending on the number of e.s.u.'s finally validated. A population of this size will preserve 90% of the average genetic diversity of the population for the next century and once the target size is attained produce 7-10 rhinos per year for return to the wild (assuming an annual growth rate of about 5%).

- The Action Plan recommends biochemical genetic studies as soon as possible to investigate if the subspecies or regional populations do represent e.s.u's.

PRIORITY ACTIONS

PHASE 1: Years 1990-2000

- Improve protection and management of the 7 to 9 sanctuaries for the actually or potentially viable populations. The goal will be to attain and sustain at least the target populations. Action required is more intensive anti-poaching measures as well as efforts to arrest and reverse habitat degradation.

Country	Sanctuary	Requirements	Cost		
			Capital		Operation
			Unit	Total	Per Year
Indonesia:	**All**	- Rhino Service Coordinator			$15,000
		- Hdqs./Office		$60,000	12,000
		- Equipment			
		- 4-Whl Drv Vhicl	25,000	25,000	
		- Office (Computer/ Fax, etc.)		25,000	
		- 2 Multi-Purpose Mobile Units ($14000/mo. operation)			336,000
		- 32 Persons ($3000/yr/person)			96,000
		- Equipment			
		- 12 4-WhlDrvVhicl	25,000	300,000	
		- 2 Lorries	75,000	150,000	
		- Communication		30,000	
		- Other		40,000	
		- Internal Travel			50,000
		- Total		630,000	509,000
	Gunung Leuser	- Park Coordinator			10,000
		- Mobile Unit			144,000
		- 12 Persons ($3000/yr)			36,000
		- Resident Unit:			
		- 12 Guard Posts (3 Type A; 5 Type B; 4 Type C;	25,000	300,000	60,000
		- 58 Guards ($2500/yr)			145,000
		- Equipment:			
		- 3 4-WhlDrvVhicl	25,000	75,000	
		- 8 Motor Bike			
		- Communication		10,000	
		- Field Equipment		20,000	
		- Total		$405,000	395,000

Country	Sanctuary	Requirements	Cost		
			Capital		Operation
			Unit	Total	Per Year
	Kerinci Seblat	- Park Coordinator			$10,000
		- Mobile Unit			144,000
		- 12 Persons ($3000/yr/person)			36,000
		- Resident Unit:			
		- 17 Guard Posts (8 Type A; 5 Type B; 4 Type C)	25,000	425,000	85,000
		- 93 Guards ($2500/yr/person)			232,500
		- Equipment:			
		- 8 4-Whl Drv Vhicle	25,000	200,000	
		- 13 Motor Bike	2,500	32,500	
		- Communication		10,000	
		- Field Equipment		20,000	
		Total		687,500	507,500
	Barisan Selatan	- Park Coordinator			10,000
		- Mobile Unit:			144,000
		- 12 Persons ($3000/yr/person)			36,000
		Resident Unit:			
		- 6 Guard Posts (2 Type A; 2 Type B; 2 Type C)	25,000	150,000	30,000
		- 30 Guards ($2500/yr/person)			75,000
		- Equipment:			
		- 2 4-Whl Drv Vhicle	25,000	75,000	
		- 4 Motor Bikes	2,500	10,000	
		- Communication		10,000	
		- Field Equipment	20,000		
		- Total		$245,000	295,000

Country	Sanctuary	Requirements	Cost		
			Capital		Operation
			Unit	Total	Per Year
	Kayan Mentarang	- Park Coordinator:			$10,000
		- Mobile Unit:			
		- 12 Persons ($3000/yr/person)			36,000
		- Resident Unit:			
		- 10+ Guard Posts	25,000	250,000	50,000
		- 50+ Guards ($2500/yr/person)			125,000
		- Equipment:			
		- 4 4-WhlDrvVhicle	25,000	100,000	
		- 10 Motor Bikes	2,500	25,000	
		- Communication		10,000	
		- Field Equipment		20,000	
		- Total		$405,000	221,000
	Ujung Kolon (Javan Rhino)				
INDONESIA TOTAL				$2,372,500	1,927,500

Country	Sanctuary	Requirements	Cost		
			Capital		Operation
			Unit	Total	Per Year
Malaysia:	All	Rhino Unit	?	?	?
Peninsula	Taman Negara	Resident Units	?	?	?
	Endau Rompin	Resident Unit:			?
		- 4 Guard Posts	110,000	440,000	
		- 4 Quarters @20,000	80,000		
		- Utilities/Infrastruct.	10,000		
		- Office/Storage	20,000		
		- Equipment:	40,000	160,000	
		- 1 4-Whl Drv Vhicle	20,000		
		- Patrol Boats	10,000		
		- Radios, Cameras	8,000		
		- Camping Equip.	2,000		
		Total		600,000	
Sabah	Tabin	Resident Unit:			?
		- 3 Guard Posts	110,000	330,000	
		- 4 Quarters @ 20,000	80,000		
		- Utilities/Infrastruct.	10,000		
		- Office/Storage	20,000		
		- Equipment:	40,000	120,000	
		- 1 4-Whl Drv Vhicle	20,000		
		- Patrol Boats	10,000		
		- Radios, Cameras	8,000		
		- Camping Equip.	2,000		
		Total		450,000	
	Danum Valley	Resident Unit:			?
		- 1 Ranger Post	110,000	110,000	
		- 4 Quarters @ 20,000	80,000		
		- Utilities/Infrastruct.	10,000		
		- Office/Storage	20,000		
		- Equipment:	40,000	40,000	
		- 1 4-Whl Drv Vhicle	20,000		
		- Patrol Boats	10,000		
		- Radios, Cameras	8,000		
		- Camping Equip.	2,000		
		Total		$150,000	

Country	Sanctuary	Requirements	Cost		
			Capital		Operation
			Unit	Total	Per Year
Sarawak	Ulu Limbang	Resident Unit:			?
		- 2 Ranger Post	110,000	220,000	
		- 4 Quarters @ 20,000	80,000		
		- Utilities/Infrastruct.	10,000		
		- Office/Storage	20,000		
		- Equipment:	40,000	80,000	
		- 1 4-Whl Drv Vhicle	20,000		
		- Patrol Boats	10,000		
		- Radios, Cameras	8,000		
		- Camping Equip.	2,000		
		Total		300,000	
TOTAL MALAYSIA				**$1,500,000**	**?**
TOTAL INDONESIA AND MALAYSIA				**$3,872,550**	**?**

- Implement measures to reduce/reverse human encroachment and recover/rehabilitate habitat in these sanctuaries.

Country	Sanctuary	Requirements	Cost
Indonesia	Gunung Leuser	Relocate settlers	$470,000
		Rehabilitate derelict land	375,000
		Buffer zone mgmt.	225,000
		Education extension	15,000
		Total	1,085,000
	Kerinci Seblat	Relocate settlers	780,000
		Rehabilitate derelict land	625,000
		Buffer zone mgmt.	375,000
		Education extension	30,000
		Total	1,810,000
	Barisan Selatan	Relocate settlers	160,000
		Rehabilitate derelict land	625,000
		Buffer zone mgmt.	50,000
		Education extension	10,000
		Total	845,000
	Kayan Mentarang	Relocate settlers	780,000
		Rehabilitate derelict land	625,000
		Buffer zone mgmt.	375,000
		Education extension	10,000
		Total	$1,790,000
INDONESIA TOTAL			$5,530,000

Country	Sanctuary	Requirements	Cost
Malaysia			
Peninsula	Endau Rompin		
	Taman Negara		
Sabah	Tabin		
	Danum Valley		
Sarawak	Ulu Limbang		

- Finalize any uncompleted gazettment of major sanctuaries.

Country	Sanctuary	Action
Indonesia	Gunung Leuser	
	Kerinci Seblat	
	Barisan Selatan	
	Kayan Mentarang	
Malaysia		
Peninsula	Endau Rompin	
Sabah	Tabin	
	Danum Valley	
Sarawak	Ulu Limbang	

- Conduct more intensive surveys to verify the status of the Sumatran Rhino in Kalimantan, esp. along Sabah and Sarawak border, Thailand, and Myanmar.

Country	Area	Requirements	Cost
Indonesia	Kalimantan		
Thailand			
Myanmar			

- Depending on results of survey, be prepared to institute specific *in situ* protection/management and or captive propagation programs oriented toward recovery of the populations.

Country	Area	Action	Cost

- Conduct the biochemical studies necessary to validate e.s.u.'s within the species.

- Conduct research to improve knowledge of the ecological characteristics and requirements of the species.

Research	Cost

- Translocate rhino as appropriate to achieve metapopulation strategy.

- Continue development of captive propagation programs both in range and non-range states. In range states, place emphasis on the captive propagation programs of the wildlife departments (PHPA in Indonesia and DWNP in Malaysia) especially at facilities developed within *in situ* sanctuaries. The goal will be to develop a self-sustaining captive population of at least 150-225 rhino which can then be used to produce animals for return to natural sanctuaries.

Country	Requirements	Cost
Indonesia	PHPA Rhino Breeding Center(s)	
Malaysia		
Peninsula	Sungai Dusun	
Sabah	Sepilok	
Sarawak	?	
Thailand		
North America		
Europe		
Australia		

- Conduct research in the reproductive biology of and technology for the species to facilitate intensive and interactive management of wild and captive populations.

- Provide training in both *in situ* and *ex situ* technologies.

Training	Activity	Cost

- Support public education programs at both national and local (i.e. neighborhood of sanctuaries) for rhino.

Country	Action	Cost
Indonesia	Local Extension Programs	
	TV Programs	
Malaysia	TV Programs	
Singapore	TV Programs	

- Assist specific efforts to reduce further the trade in rhino horn in both producer and consumer countries:

Country	Action	Cost
Indonesia		
Malaysia		
Singapore		
Hong Kong		
Taiwan		
China		
Japan		
Thailand		
Myanmar		
Laos		

PHASE 2: Year 2000 and Beyond

- Commence recolonization and recovery process in areas where the rhino has disappeared:

  Thailand:

  Myanmar:

  Indochina:

  India:

  Indonesia:

  Malaysia:

APPENDIX 1

POPULATION VIABILITY ASSESSMENT: SUMATRAN RHINO

To be included in final version

(Preliminary results available in Khan (1989) and Seal & Foose (1989, 1991).

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